AN EXPLORATORY STUDY OF METHODOLOGIES FOR DIGITAL COLOUR PRINTING IN TEXTILE DESIGN, THROUGH AN UNDERSTANDING OF INTERWAR HISTORICAL COLOUR PALETTES

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Abstract

Digital printing technology has had a major impact for the textile designer. Their design process now enables them to create complicated multi-layered digital designs incorporating photographic images and intricate detail. Artwork is no longer restricted to a number of colours or a repeat pattern. Leading to new entrepreneurial business models in the textile industry, it has become possible to print a metre, or hundreds of metres, at the click of a button, without high set-up costs.

However, there are concerns about print-colour consistency and outcome. There is a gamut mismatch between the additive - mixing colours with light, and subtractive - mixing pigments or dyes, colour models used to reproduce colour on screen and in print. Numerous variables can alter colour outcome relating to textile chemistry, colour management, viewing conditions and printer technology. Yet colour accuracy is hugely important in the field of fashion and textiles, where colour is critical, and tolerance limits are competitive.

The research inquiry explored a number of variables to determine their influence on colour outcomes using a Practice-as-Research methodology to reflect the conditions and approach designers would employ. These practical experiments progressed into the development of a modality of visual colour methods, which aid a designer's colour expectation knowledge; a Colour Reference Book, Digital Lab Dip tests presented as Colour Maps, and a set of Indicator ICC profiles generated from data accumulated through measuring printed-colour differences on a variety of substrates. The modality of visual prompts is intended to support designers to build their own '*internal colour look-up table',* enabling users to predict and resolve colour issues during the design process.

The methods were applied in a real-world test case, using a body of colour work, inspired by archival research of the British Interwar period. The work has been presented as an Exhibition of Praxis, an online Project Tool-Kit, and a Written Report, which takes a traditional thesis format.

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Frequently used Abbreviations

APCC – Adobe Photoshop Creative Cloud
CIE - Commission International d'Eclairage
CMYK – Cyan, Magenta, Yellow and Black
DPB – Digital Print Bureau
DTP – Digital Textile Printing
HEI – High Education Institute
HSB – Hue, Saturation, Brightness
ICC – International Colour Consortium
PaR – Practice as Research
RGB – Red, Green, Blue

A glossary of terms is provided in Appendix A.

Chapter Overview

This written report is a complementary component to an Exhibition of Praxis and an online tool-kit which, as a whole, form the thesis submission, as typical for a Practice-as-Research (PaR) project.

The report follows a traditional five-chapter thesis structure. It presents the investigation and findings of an inquiry between science and art, working towards an understanding of colour and colour reproduction to explore and develop methodologies for digital colour printing in textile design. Using a PaR approach to reflect the approach and conditions that designers employ, the study explores and develops a modality which aims to aid and improve designers' colour expectations and help them to achieve their desired print outcomes. As a result, a set of visual colour indication methods were created, supported by pedagogic strategies formed as an openly accessible tool-kit. The study evaluates the effectiveness of the visual colour methods by testing a specific colour range and body of design work in the form of a Colour Archive, derived from historical archival research.

Chapter One introduces the research project to provide essential context and justify the need for the study. It prefaces the inquiry by presenting the researcher's positionality, role, and rationale for conducting the research. The chapter establishes the research questions, aims and objectives that focus the research direction, and presents the key researchers examining this domain which the study builds upon. Furthermore, it outlines the scope and offers a preview of the key findings from the Contextual Review, which situates the research project within the broader context of colour practice, traditional colour and digital print research, and other, external knowledge. The chapter also introduces the research paradigm, the philosophical and methodological framework underpinning the project, importantly highlighting the multi-mode epistemology of Robin Nelson's PaR model employed by the inquiry. In conclusion, the chapter provides a preview of the project's significance, its contribution to knowledge, and the outcomes and outputs.

Chapter Two offers a comprehensive account of the **research methodology** employed in the study to clarify the PaR methodological approach and justify the rationale behind its

selection. The underpinning schools of thought to Nelson's multi-mode epistemological framework are emphasised alongside how the studio-based research yielded unique insights distinguishing it from more commonly employed scientific and social science research methodologies. Next the chapter presents the understanding taken by the inquiry that there are multiple possibilities of colour, described through both subjective and objective elements and informed by phenomenological and explanatory approaches to foster exploration and embrace an open-ended, experimental approach appropriate for a PaR methodology. Finally, each research activity is presented with a thorough methodological explanation, highlighting alignment with Nelson's three interconnected modes of knowing, to demonstrate how experiments effectively addresses the research questions and contribute to the research narrative and overall aims and objectives of the study.

Chapter Three presents the data-gathering and sifting of traditional research literature, colour practice, and insights from industry experts to understand the colour problem in digital textile printing (DTP) and present the tools for preparedness and underpinning philosophies. The chapter positions the inquiry within a **contextual review** that encompasses content beyond the textual to survey current design approaches, assess production challenges, provide examples of designer engagement and review strategies used to improve colour outcomes. Significantly, the chapter presents a series of professional testimonies from industry experts in the form of a Colour Conversations Case Study. These testimonies serve as evidence and illustrations of the current state of knowledge and practice in the field. The chapter also addresses the issue of subjectivity concerning visual assessment. It highlights the relevance of developing a tool-kit designed to support the working practices of designers, intending to be perceived as valuable and adopted by the design community. Moreover, it emphasises the connections between contextual external knowledge and the multi-faceted reality of colour to address the research questions, thereby establishing five significant challenges; gamut mismatches, numerous variables, adapted technology, outsourced processes and inconsistencies in design education and limited designer knowledge. These challenges are identified as factors that impede colour accuracy in DTP.

Chapter Four provides a narrative account of the **experimental** activities conducted to address the research questions and achieve the project aims and objectives. This section begins by outlining the praxical experiments undertaken and provides an analysis of the results of these experiments. Interweaving supporting information and contextual material showcases the integration of theory and practice within this praxical [1] research and provides a coherent explanation for why this body of work was developed as an Exhibition of Praxis. Importantly this chapter connects the theme of improving Colour Expectation in DTP to link with the Colour Archive evaluation through a British Interwar Case Study a real-world test case and an integral part of the project. The chapter concludes by highlighting the discoveries made through generating this body of work and discussing the implications with regards to the research questions and objectives.

In the final chapter, **Chapter Five,** the report **concludes** by critically evaluating and summarising the research project's findings. It provides a comprehensive presentation of the project outcomes, discussing their significance and the contribution of original knowledge generated through the inquiry. Moreover, the chapter offers recommendations for future research and next steps and outlines the potential avenues for further exploration.

Chapter One

Introduction

This chapter sets the thesis of the research. Seeking to understand why colour matching in digital textile printing (DTP) is challenging, this research endeavours to contribute to a better understanding of this emerging technology and the potential engagement opportunities for the design community. The research asks what measures a designer must take to feel colour confident and how can scientific theory and production processes be understood and utilised to support this Using a multi-modal epistemology and practice-as-research methodology, the researcher examines the multiple possible realities of colour, reflecting the circumstances and working practices of designers; the inquiry seeks to understand the colour problem and the tools for preparedness to improve Colour Expectation and gain acceptance through applying colour knowledge with a Colour Archive. The thesis highlights five significant challenges to colour in DTP and advocates for industry standardisation to address these issues effectively.

1.1 Establishing the Research Project

Digital technology has had a significant impact for the textile designer (Kelly, 2014). Their design process now enables them to create complicated multi-layered digital designs incorporating photographic images and intricate detail. Artwork is no longer restricted to a number of colours or a repeat pattern (Tyler, 2005) as there is no need to accommodate the size of a screen or to separate by colour. Leading to new entrepreneurial business models in the textile industry, it has become possible to print a metre, or hundreds of metres, at the click of a button, without enormous set up costs, (Ujiie, 2006a).

DTP, in particular, provides an unprecedented opportunity for designers to offer bespoke and customised designs (Polston et al, 2015). Just in Time and Concept to Consumer production models (King, 2006; ASBCI, 2014b) benefit from short print runs and expedited strike-offs, product sampling and testing made possible by DTP (Dawson, 2006b).

Reduced ink wastage and water use makes DTP a more environmentally sustainable printing method (Dawson, 2010). Digital Print Bureaus (DPBs) are likely to be located in an urban environment, local to their customers, with reduced transport costs, and occupying less space than a traditional textile mill or factory (Ujiie, 2006a). Short print runs and the ability to react quickly to market trends allow businesses to carry less stock, reducing storage costs, and the likelihood of stock wastage as fabric is printed to demand (Ujiie, 2006). These changes offer exciting possibilities for designers and small and medium-sized enterprises (SMEs), such as design studios working in the textile industry.

However, concerns about print-colour consistency and outcome are demonstrated through extensive research conducted in the field (Leak, 1998; Tyler, 2005; Ujiie, 2006b; Carden, 2015) and accounts from industry experts in the textile industry interviewed for the inquiry. For example, there is a marked difference between screen-colour and print-colour (Best, 2012) which does not meet strict colour tolerance levels (SDC, 2008). Software allows users to select colours unprintable using CMYK (cyan, magenta, yellow and black) colourants (Campbell, 2006). Fabric pre-treatment, secondary processes, and the printer's achievable gamut, a range of colours in a given colour space, all affect the final colour result (Hawkyard, 2006). The assortment of printing machines, and the methods that they use to apply and represent colour, also impede the designer's understanding (Romano, 2017). The use of technology and colour management processes adapted and developed for the smooth surfaces of reprographic printing (Dawson, 2000) further complicates the issue.

A designer may choose from various image-editing software and print via ink-jet or dye sublimation processes onto numerous fabrics. Thus, a textile designer will be required to experiment with an assortment of variables to feel colour confident which may be time consuming, costly, and imprecise (Campbell, 2006).

1.2 Introduction to Digital Textile Printing

Unlike traditional textile printing methods, digital textile ink-jet printing is a non-surface-impact print process. Colourants, primarily dyes, but increasingly pigment inks, are jetted in a dithered matrix of dots onto specially treated fabric to create the appearance of blends of tonal colour (Carden, 2015). The colourant is deposited onto the fabric. Secondary processes allow dye molecules to permeate the fibres (Freire, 2006). DTP encompasses a range of printing technologies including dye sublimation, solvent, latex, ultra-violet, and direct-to-garment printing, for example T-shirt printers (Romano, 2017).

The praxical experiments presented in Chapter 4 were conducted using the print set-up available at UWE Bristol which is a wide format digital ink-jet textile printer equipped with reactive dyes for printing on pre-coated, natural fibres. The printer and colourant set up is depicted in Figure 2 and technical settings listed in p74. Consequently, the research focuses primarily on colour considerations in digital ink-jet textile printing on natural fibres, to reflect the specific print environment and conditions utilised for the research. This narrower scope acknowledges that similar challenges may also arise in other forms of DTP such as dye sublimation.

By concentrating on the colour challenges specific to digital ink-jet textile printing while also considering broader DTP technologies, this research will contribute to an enhanced understanding of this emerging technology, demonstrating potential engagement opportunities for designers, design studios, and the wider textile industry.

1.3 Establishing the Need

1.3.1 Why is colour critical in Digital Textile Printing?

Colour is critical in the textile industry and can ensure a product's success or failure (Cassidy, 2005). Colour accuracy is necessary to meet trends, client requirements and to obtain consistency (Udale, 2014). Industry colour tolerance levels are meticulous (SDC, 2008) and considerable resources are devoted to colour forecasting to ensure that products meet market demands e.g., consistent colour between batches, garments, and different fabrics. Printed textiles may be required to complement other products as a part of a collection or match garment components such as a zipper or button. Construction techniques, for example pattern cutting, may mean that for efficiency a product is formed from different print batches. Subsequently colour changes, however subtle, will have an impact on whether that product passes quality testing. Unsold products become deadstock and may be sold below cost price, or destroyed, which is uneconomical and wasteful (Moazzem *et al.*, 2021). Thus, maintaining colour consistency and ensuring predictability is vital to attaining product success and purpose.

The DTP industry accounts for 5.5% (Ross, 2018) of global textile production, or 1.9 billion square metres of fabric, and is predicted to rise. The global textile industry is worth 3 trillion USA dollars making DTP worth 165 billion dollars (Hayward, 2017). Also, the textile industry is one of the world's largest polluters. Therefore, the financial and environmental consequences of colour mistakes in DTP therefore reduce profit margins through re-printing and corrective colour sampling and increases waste through unsold stock. A conversation with a DPB, Be Fab, as part of interviews with industry experts, revealed that due to colour issues reprinting frequently happens in DTP, reducing tight profit margins and increasing wastage (Appendix F p8).

1.3.2 *Colour determiners* - How can designers be the solution?

Designers are responsible for directing and commissioning the colours in the design although the process may be initiated from a brief or colour trends (Shen and Xin, 2006). It is the designer's role to utilise and implement the colour palette (Clarke, 2011) as *colour determiners*. Therefore, a significant potential solution to the issue of printed-colour

outcome would be to ensure that designers are aware of the challenges in achieving colour fidelity. For example, understanding of how numerous variables impact colour in the DTP process. The rationale being that if unprintable colours, or colours that can be challenging to print consistently, are identified in the early design process, measures can be taken to resolve them in the design stage, reducing the possibility of issues in production.

Current research from Kelly (Kelly, 2014) and Henry (Henry, 2013), which the inquiry further evidenced through a survey of print technicians at 3 Higher Education Institutes (HEIs) (Appendix F, p108), establishes that training in DTP and digital colour is lacking in design education and that there is no best practice for designers seeking guidance on colour outcome in DTP[2]. Accessible education is, therefore, required in both colour and print technology beyond university teaching and vocational study. Such education should consider the challenges designers from other disciplines face when engaging with DTP. These designers may lack awareness of textile properties and the chemistry required for colouration as fibre characteristics impact how dyes bond which impacts colour outcome (Britt, 2012). Hence, the inquiry suggests the development of an online tool-kit with foundational information to provide the designers with necessary knowledge and guidance to help achieve more accurate colour outcome in DTP.

In addition to accessible education, industry bodies must also provide further solutions to address the issue of colour fidelity in DTP. Therefore the inquiry recommends the development of industry standards and guidelines to help ensure consistency issues across the industry, reducing the need for reprints and waste.

1.3.3 How do designers currently work with colour?

Designers primarily use visual references, for example colour charts (Udale, 2008; Clarke, 2011). Figure 1 depicts a set of charts devised by Designer Jacqueline Milton, which she used for testing, which altered hue value's grey content. Designers also use software tools, drawing on methods derived through trial and error to assist them with finding their own colour solutions (Appendix F p37). These working methods are complemented by various visual tools such as Pantone© swatches (Clarke, 2011). This was evidenced in the Colour

Conversations, where industry experts used a range of visual clues to support their colour work, including built-up colour knowledge - *designer's eye*, colour sampling and testing, and acquired knowledge of colour management such as profiling. There are various colour support products commercially available which range in price and quality (Eiseman, 1990; McKeegan, 2017; Romano, 2017; Weidt, 2017d; Ding et al, 2018). However, due to the abundance of equipment available it can be challenging to navigate and ascertain their usefulness and necessity without greater knowledge about the DTP process works and the variables involved.

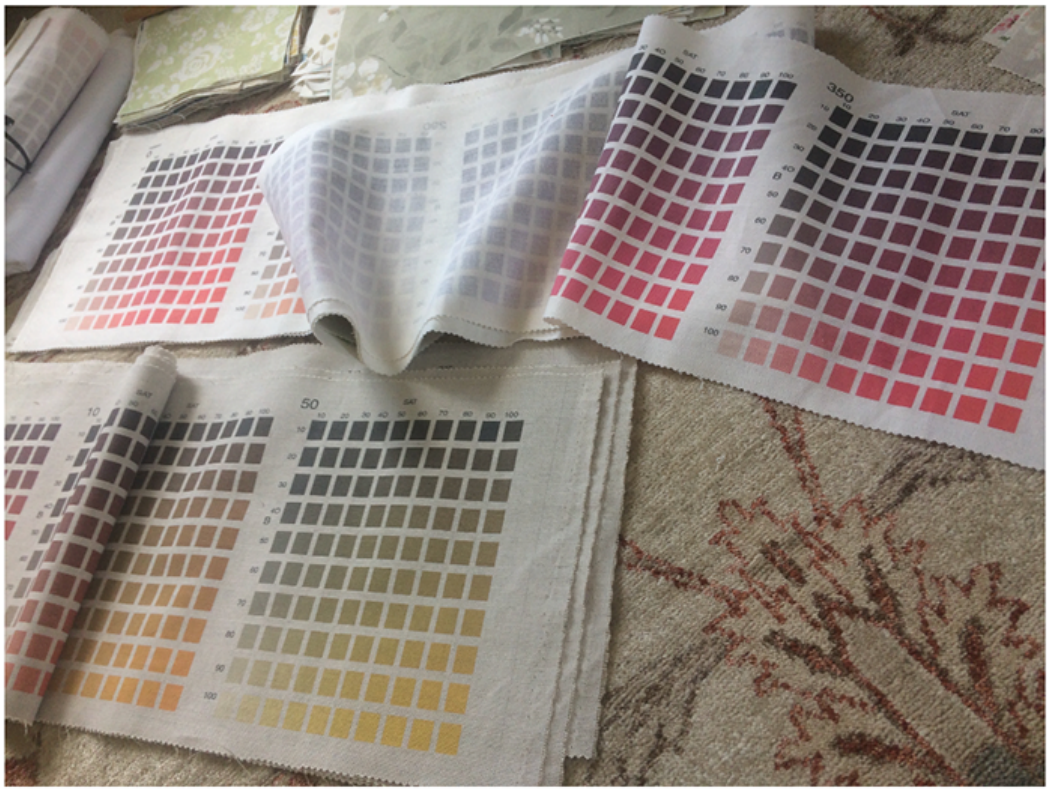

Figure 1 Gooby, B. (2018) Designer Jacqueline Milton's self-devised colour test sheets. Image taken during Colour Conversation

1.3.4 Barriers to existing research in DTP research field

Many designers lack access to and an understanding of, the dominant research currently undertaken and published in this field (Henry, 2013) and as evidenced by the accounts of industry experts. Research primarily involves scientific and technological fields such as textile chemistry (dyes, coatings, colourants, impact of secondary processes steaming and

washing) and printer colour management. Research is published in academic journals and books, and trade publications, which are not widely accessible and frequently pay to view. There is an absence of a designer's point of view in journals such as Textiles Research and Coloration Technology and further barriers through technical language. Apart from practical *how-to* publications (Bowles and Isaac, 2012), there is a gap in knowledge and insight addressing this issue from a designer's perspective (Nicoll, 2006). The designer's perspective is essential because they make critical choices about the colour palette and the placement of colour in the artwork (Nicoll, 2006).

There are added financial barriers, such as access to colour measuring equipment, specialist software and technology, subscription to access publications, commercially restricted information, and training in using these tools. Commercial sensitivity within the colour management industry means openly accessible and shared information is absent, as corroborated by the account of industry expert Be Fab (Appendix F p5).

1.3.5 Defining the audience for the inquiry – the designer community

The intended audience for this inquiry, therefore, are freelance designers and small, medium enterprises (SMEs) such as design studios like the industry experts interviewed (BlackPop, Earthed Fabrics, Studio Flock and Made in Brighton) who are engaging with digital textile printing technologies but lack access to specialist colour software, equipment and knowledge which seeks to support, resolve, and improve colour outcomes in the industry.

Figure 2 Gooby, B. (2015) Digital textile printer at UWE; Mimaki TX2-1800 with Reactive Dyes (inset)

1.4 The Know-How, rationale for the Project, and mitigating positionality

The role of the researcher in the inquiry is that of a practitioner-researcher. A person with professional skills in the subject that they are investigating (Barrett and Bolt, 2014). This is termed the Know-How in Nelson's epistemological model. The research arose from the researcher's personal experience as a textile designer working with DTP encountering colour matching and consistency issues in their practice, which were confusing and frustrating, primarily because the process is outsourced. The Know-How is presented here and signposted in p85. to maintain transparency and counteract accusations of subjectivity.

As a freelance, computer-aided-design, printed-textile designer the researcher has seen the industry develop in the UK since 2008. Initially colour issues were noticed with a few off-reds or oranges which were brighter than anticipated when printing on cotton and incredibly garish and acidic yellows which should have been gold when printing on silk habotai. DTP is expensive, starting at £20 per metre minimum, so colour sampling is costly. Despite the colour mismatches the bureau never acknowledged them, and the researcher felt too inexperienced to query them, thinking they must be doing something wrong. To address the problem, they began to use Adobe Photoshop (APCC) tools such as the vibrance and saturation balance to adjust artwork and tone down the colours on screen, thus toning down the printed colours on silk, but this haptic method did not produce consistent results. The issue was further exacerbated when they started printing on linen and encountered the opposite problem of very faded and muted colours.

Upon speaking with other designers, the researcher discovered that colour mismatches in DTP were a common issue. Some designers were content to accept the mismatches and pleased with the process efficiency, while others avoided DTP as a medium altogether. It became essential for the researcher to understand why colour matching in DTP is challenging and to provide support to themselves and other designers to fully utilise this exciting technology.

271.4.1 Mitigating the Positionality of the Researcher

Multiple perspectives were incorporated to minimise the impact of the positionality and viewpoints of the researcher. Examples include industry experts accounts in the Colour Conversations Case Study, and via critiques, peer review, feedback, and expositions for example presentations at conferences. This was further triangulated by incorporating a review of existing research and the practitioners perspective to understand the colour problem and tools for preparedness in the Contextual Review. Furthermore, critical reflection and reflexivity were incorporated throughout the inquiry to maintain focus, including documenting experiments to maintain transparency.

1.5 Research Questions, Aims and Objectives

1.5.1 Research Questions (RQ)

To address the problem of colour matching in DTP from the perspective of the designer, two themes were established to focus the approach and position the inquiry within a tight framework; Colour Expectation and Colour Archive and developed into a formal set of research questions.

1.5.2 Colour Expectation

- RQ1 What measures must a designer take to feel confident with their colour use in digital printing on cloth?

- RQ2 How can the design community understand and utilise scientific colour theory and production methods for digital printing?

1.5.3 Colour Archive

- RQ3 How can historical colour inform colour aesthetics in digital textile printing?
- RQ4 How did colour use develop in the British Interwar Period?

To address the research questions and articulate the findings of the inquiry, the following aims and objectives were proposed:

1.5.4 Aims

1. To develop a tool-kit, that is accessible to artists, designers, and SMEs without access to commercial resources and chemical colour knowledge/science, which guides to improve colour match when printing from digital printers on to fabric – addressing RQ1 and 2 (Colour Expectation)

2. To create a historical digital colour palette, which re-creates colours from the interwar period as a real-world test scenario – addressing RQ 3 and 4 (Colour Archive)

1.5.5 Objectives

1. Survey and compare different digital colour printing systems for textile designers (RQ1 and Aim1)
2. Use interviews and case studies to identify the strengths and weaknesses of current textile printing practice (RQ1 and Aim1)
3. Co-ordinate a network of experts to facilitate a series of case studies, titled Colour Conversations (RQ1 and Aim1)
4. Establish a coherent body of colour work using digital textile printing (RQ1 and Aim1)
5. Undertake a historical literature survey on the colour palette in the British interwar Period (RQ2 and Aim 2)
6. Create a historical archive of colour used in the British Interwar Period (1918-1939) (RQ2 and Aim 2)
7. Test and apply these colours as part of my own practice (RQ2 and Aim 2)

This scholarly framework has guided and held the focus of the research, leading to the creation of the research outputs, outcomes, and findings. The activities undertaken to address the research questions, aims and objectives are presented in Chapter Two- Methodology, and Chapter Four- Experimental, and referenced through-out the exegesis.

1.6 The solution proposed by the inquiry

The inquiry proposes that a solution to the problem of colour matching in DTP would be to provide designers with techniques and information, in the form of a tool-kit which allows them to manage colour expectation and make changes in the preliminary design stages to improve colour outcomes in DTP. The potential impact of this approach lies in its ability to serve as an educational tool, offering insights into the variables that influence colour, and making informed decisions. For example, restricting the number of substrates they work with. The aim of providing of basic and essential information on DTP is to enable designers to be able to communicate more effectively with DPBs and support problem-solving when printed colours are not as expected (McKeegan, 2017). Addressing colour issues in the design stages prior to production, has the potential to reduce the need for reprints impacting cost and waste and the need for reprints. Ultimately, the research seeks to allow designers to improve their ability to be creative without being encumbered by technical issues (Polston et al, 2015).

The resulting tool-kit encompasses documented practical experiments with variables and introduces a modality of visual colour methods developed as a crucial inquiry component. The methods seek to assist designers to build their DTP colour knowledge, resembling an *'internal colour look-up table'* (Henry Appendix F, p103.), with the potential to enable them to predict and resolve colour issues during the design process.

The inquiry describes these strategies as visual colour methods because each employs a specific and developed technique, visualising colour changes from screen-to-print to achieve the overarching goal of supporting designer's colour expectations and enhance colour accuracy in DTP. Each method is linked because they each focus on the influence of substrates on printed-colour outcome. The aim of offering visual approaches is to reflect designers' circumstances and promote acceptance.

The modality of visual colour methods is comprised:

1) a Colour Reference Book, which evidences the differences between screen and print-colour across different substrates and colour range, alongside colour data, allowing designers to look up colours and anticipate how they might print,

2) a set of Digital Lab Dip tests presented as Colour Maps to demonstrate how a colour might shift in hue, saturation and brightness when printed, depending on the substrate choice, and

3) a set of Visual Indicator ICC profiles, generated from data accumulated through measuring printed-colour differences. These show on screen how colours might alter when printed on different substrates in an overall design.

By providing this information as an open access tool-kit the inquiry aims to enhance the advancement of DTP for creativity and entrepreneurial business models. Additionally, this research seeks to feed into industry organisations to prompt further research.

Interwar Case Study - Using a colour archive as a mechanism for testing

To evaluate the usability and value of the modality of visual colour methods an application of colour knowledge, formed as a British Interwar case study was undertaken using a specific colour palette generated from historical archival research of the British Interwar period (1919-1938).

The British Interwar period was chosen because it was a time of great textile technological modernisation, change and innovation, with the advent of cheap, chemical colourants, synthetic fabrics, and the emergence of silk screen textile printing (Saler, 1999). Presenting a comparative situation similar to that which designers encounter when working with DTP - introducing new technologies and increased design flexibility, including colour and detail, requiring adjustments in design language and technique.

There was a significant period of change, with multiple factors contributing to design and color use. Britain's house building boom and increased availability of mortgages meant that homeownership and, therefore, interior decoration were made available to the masses

(Cohen, 2006; Guffey, 2006). New modernist concepts of sleek and neutral interiors emerged alongside a brightly coloured '*Moderne'* (Guffey, 2006, p.68) or Art Deco palette, creating a distinctively British look (Potvin, 2015). This contrasted with a darker Victorian and Edwardian palette that also remained fashionable. Brighter colours were introduced as a result of new chemical technologies. Manufacturing by machine increased as technology developed, and a new textile printing method was introduced - silk screen printing. Designers engaging with these novel processes and mediums had to establish new working methods. For example Eileen Hunter (1909–1979) writes about how frequently the printers mistranslated the colours in her designs, with blues printed as purple and greys as pink (Hunter, 1979). Similarly, Enid Marx (1902-1998) spoke about the frustrations of communicating design ideas to manufacturers and the separation of designer from production (Marx, 1980). The Design and Industries Association, set up in 1915 to support the creative industries with the transition to mechanisation, called for better integration between manufacturing and '*industrial artists'* (Saler, 1999) and promoted the incorporation of industry-led design education.

Drawing inspiration from archives is a common design practice, making the creation of a Colour Archive using historical archival research a suitable real-world test case and a familiar and accessible mechanism to introduce the modality of visual colour methods to the design community engaging with DTP. Collectively, these factors create a compelling rationale to draw upon this significant period for study. It provides an opportunity to explore for colour inspiration and assess responses to changes, specifically focusing on the increased availability of colours and advancements in printing technology.

1.7 Methodology

The project framework deploys a research methodology that embraces the concept of PaR to acquire knowledge through practice or Praxis, a method of purposeful, creative investigation which values naturalistic inquiry. The approach has evolved from Social Science methodologies rooted in philosophical principles that encompass the examination of the process and the researcher's specialist expertise as a discovery tool. Moreover, it ascribes the utilisation of varied research methods to account for multiplicity and, thus, adapted by creative fields including fine arts, design, crafts, performance, media, and cultural studies. PaR seeks to bring creative research into the academy structure (Nelson and Arlander, 2013) and position the unique insights that creative practitioner-researchers bring. Key scholars and proponents include Christopher Frayling (1946-), Robin Nelson (1949-), Estelle Barrett (1949-), Barbara Bolt (1950-), James Elkins (1955-), Julian Malins (1959-), Graeme Sullivan (1962-), Carole Gray (1963-), and Patricia Leavy (1975-).

1.7.1 Colour Ontology

In keeping with the spontaneity and playfulness required of a PaR methodology, the inquiry takes the perspective that colour has multiple possibilities, enabling open-ended exploration and discovery by fostering an *anything goes* approach to colour. This stance adopts a pluralist realist standpoint (Matthen, 2005) which understands that colour may be experienced both as an idea of colour (subjective), which is perceptual and contextual, and as a secondary quality, about an object's property (objective) (Lewis, 1994). Furthermore, the inquiry acknowledges the influential role that internal factors (subjective) and external (objective) have in shaping our comprehension of the reality of colour from a relationalist stance (Cohen, 2004). In recognising that colour may be positioned as both subjective and objective, the inquiry can draw upon and integrate diverse content from scientific, technological, and creative realms to address the research questions, aims and objectives.

1.7.2 Epistemology

The research draws upon a multi-mode epistemological model of Robin Nelson's three interconnected modes of knowing framed as Know-How, Know-What, Know-That (Nelson and Arlander, 2013). The model identifies the different and familiar pathways to knowledge

that creative practitioners use to generate a framework of insight. Thus, the modes draw together the tacit knowledge or Know-How of the practitioner with knowledge of what works, Know-What, and data-gathering and sifting of existing research knowledge to Know-That. The modes interconnect through reciprocal enlightenment and cyclical reflexivity. The approach seeks to be highly effective in tackling real-world challenges and finding practical solutions which require new ways of thinking. Nelson's model is underpinned by philosophical thought advocated by Ludwig Wittgenstein (1889-1951), Donald Schon (1930-1977), Harry Collins (1943-) and John Law (1946-).

1.7.3 Qualitative aspects of the Research

To incorporate multiple perspectives and evaluation, two case studies underpin and corroborate the research and draw from additional methodologies as typical of a multi-modal inquiry.

Colour Conversations

Fifteen purposeful qualitative research dialogues with industry experts concerning colour in their practice and experience of DTP to identify the strengths and weaknesses of current textile printing practice (Objective 2 & 3) to improve Colour Expectation. These seek to evidence and understand the problem of colour in DTP, detail the tools for preparedness and solutions designers use, and expand the inquiry by considering various experiences and engagement with DTP

British Interwar Case Study

A real-world application formed as a Colour Archive, drawing upon historical archival research and a survey of literature (Objective 5) to produce a collection of designs and colour palettes (Objective 6) in conjunction with a comparison of technological innovation from a past era. The body of work was used to test the modality visual colour methods developed (Objective 7).

1.8 Contextual Review

The data-gathering and sifting of external content has been grouped into two components; understanding the colour problem, and tools for preparedness to examine content in the field of DTP and beyond, encompassing, but not limited to; surveying current design approaches, examples of designer engagement, colour reproduction in DTP, production challenges, colour categorisation challenges, commercial colour systems, gamut mapping, problems in relation to subjectivity in visual assessment, colour consistency and problems encountered, colourants, substrates and textile chemistry and colour education. Additionally, following Nelson's model the research has considered the practitioners' approaches to understanding and working with colour and DTP.

1.8.1 Scope

At the outset of the project an initial and rough mapping exercise, depicted in Figure 3, plotted the range of fields for review. Consequently this was updated at the end of the project, as shown in Figure 4. It was a challenge to limit the scope of the project due to the necessity of establishing a basic grounding of different topics. This included gaining a new vocabulary and comprehending different terminologies to gain essential and broad knowledge of various factors that impact colour outcome, through holistic research.

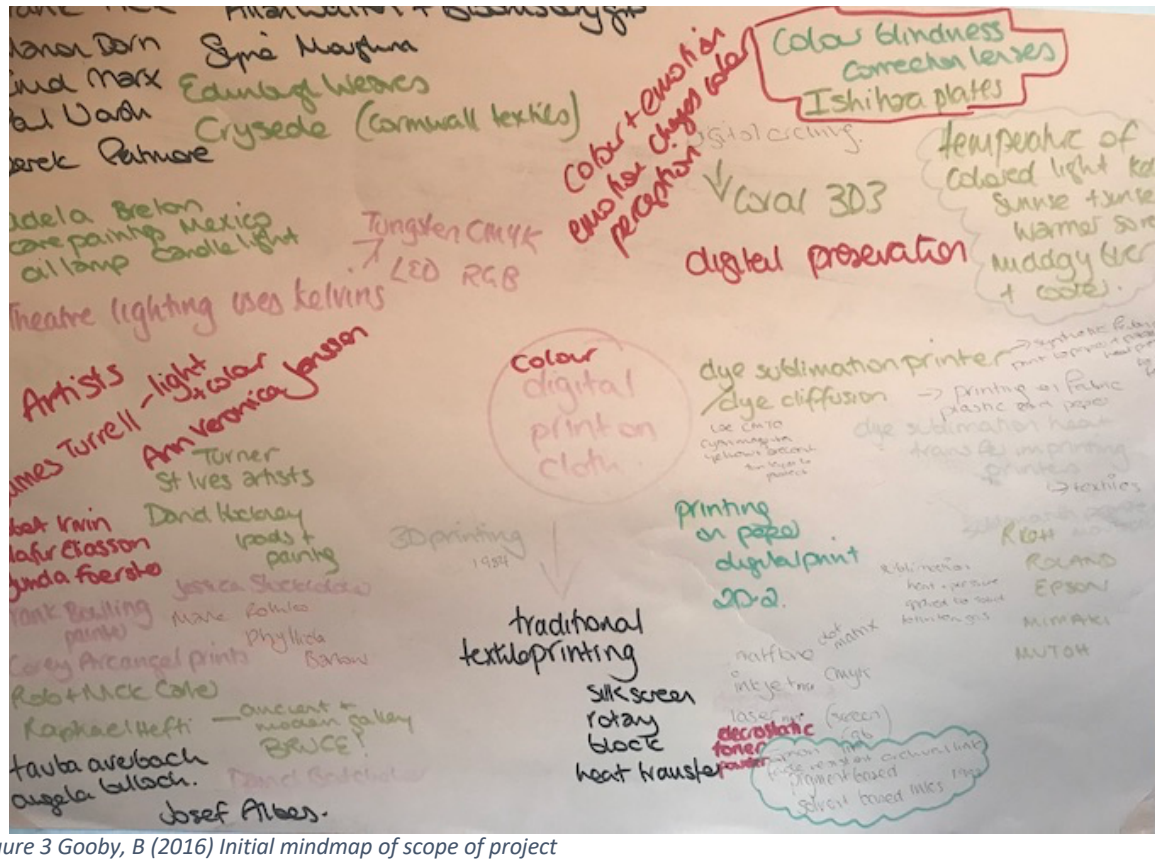

Figure 3 Gooby, B (2016) Initial mindmap of scope of project

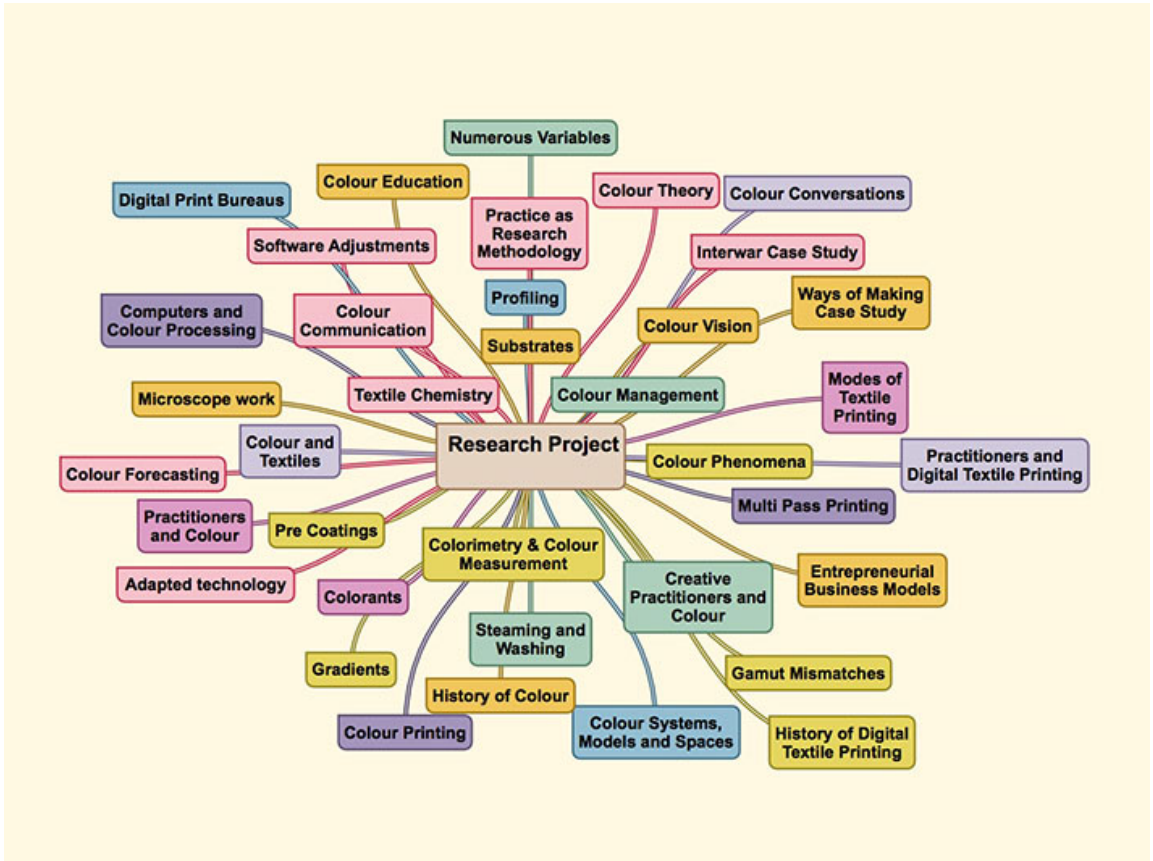

Figure 4 Gooby, B. (2020) Final mindmap of scope of Research Project

1.8.2 Significant challenges

The project proposes that colour accuracy and consistency in DTP is made more difficult by five significant issues which are summarised in Table 1 and are further signposted within the subsequent chapters. The hypothesis arose through conducting a series of conversations with industry experts, data-gathering and sifting for the Contextual Review, and praxical investigations, which are outlined in Chapters Three and Four.

Gamut mismatches	There is a mismatch between the gamut range of the digital screen-colour, RGB (red, green, and blue light) to that of the printed-colour, CMYK colourants (Westland and Cheung, 2012b, 2012a). Whilst there are overlaps between the two-colour spaces, there are many colours possible in one, but not the other, thus out-of-gamut. (Kelly, 2014)
Numerous variables	There are numerous variables that affect colour fidelity in the DTP process. Figure 5 visualises many of the variables identified. Some are distinct to DTP; others are problems shared with the reprographics and photographic industries. Designers may not have control over some of these variables and it can be difficult to predict and maintain colour accuracy through-out the DTP process (Carden, 2015). 17/08/2023 11:50:00
Adapted technology and processes	Added problems stem from the adaptation of existing print machinery (Carden, 2015) and colour management systems from reprographic printing technologies for DTP, which do not accommodate for textile chemistry, characteristics of cloth substrates, and the pre-requisites of their end use (Ding, 2016).
Outsourced and remote production method	Production is primarily outsourced to a Digital Print Bureau (DPB) due to financial barriers and practicalities. For example, having access to a large enough space to operate a wide format printer alongside steaming and washing facilities. However this removes the designer from the experience of the print process which, in conjunction with the preservation of commercial sensitivities by

	the DPB, obstructs their capacity to resolve colour issues or understand why they might arise. This can hinder the designer's ability to work with the DPPB, and ask the appropriate questions.(McKeegan, 2017)
Inconsistent design education and lack of industry guidance and standardisation	Education on digital colour and DTP is inconsistent across undergraduate design curricula (Henry, 2013) and therefore there may be gaps in their knowledge and understanding. Additionally, there is an insufficient understanding of DTP in the wider design community (Kelly, 2014). There is no best practice guidance on colour in DTP from industry bodies such as Society of Dyers and Colourists (SDC) or Association of Suppliers to the British Clothing Industry (ASBCI) and consequently a lack of standardisation in production (Ding, 2016). Without clear guidelines, it can be challenging for designers and DPBs to agree on how to approach colour management in DTP, which can lead to inconsistencies and errors in production.

Table 1 The Key Issues that make colour matching challenging in Digital Textile Printing

Figure 5 Gooby, B. (2018) Collage representing some of the numerous variables that impact printed-colour outcome

The direct bearing of the five significant challenges on the research questions

The five significant challenges identified have a direct bearing on the research questions and aims of the inquiry in that they relate directly to the problems designers face in improving Colour Expectation. Therefore consideration of these challenges must be made when addressing the measures that designers must take to feel confident with their colour use (RQ1) the scientific theory and production methods for digital printing which need to be understood by the design community(RQ2). Additionally, these challenges are present within the Colour Archive element of the study, in that the creation of a real-world test scenario using a historical colour palette (Aim2) from addressing RQ3 and 4, highlighted the complexity of resolving colour in DTP derived from these challenges, and the difficulties that designers face in trying to overcome them.

1.8.3 Key people

The inquiry builds upon the foundational knowledge and contributions of a range of researchers. Figure 6 is a diagram mapping out the significant people and areas of research and has created to situate the project at the intersection of various fields and disciplines. The diagram seeks to highlight the gap in knowledge that this project fulfils as a practical investigation of colour in DTP from the perspective of a designer and covers Textile Technology and Industry (Orange), Colour Management in DTP (Green), Colour and Digital Printing in other mediums (Dark Grey), Digital Textile Printing from designer perspectives (Grey), Digital Creativity and Design Education (Pink) and Textile Chemistry (Yellow).

Table 2 lists their key publications or other contributions to knowledge

NB Ujiie spans Textile Technology and Industry and Colour Management in DTP

Captions for the following models p39 and 41

Figure 6 Gooby, B. (2020) Visualisation of key people identified as result of Contextual Review

Table 2 List of key publications by key researchers

Hitoshi Ujiie
Surface
Imaging
Timothy L
Dawson
Textile
Technology &
Col Mangmnt
D. Javorsek &
A. Javorsek
Surface
Imaging
John Provost
Textile
Chemistry
David J Tyler
Textile
Technology &
Industry
Bunting,
Fraser,
Murphy
Col Mangmt
Katherine
Polston
Digital
Creativity &
Education
Chris
Hawkyard
Textile
Chemistry &
Colourants
Yi Ding
Colour
Management
in DTP
Phil Green
Digital Colour
Melanie
Bowles
DTP & Digital
Embroidery
The Project:
Praxical
Investigations
into colour in
DTP
Carinna
Parraman
Colour
Hella
Jongerius
Design &
Colour
Amanda
Briggs-Goode
Design
Education
Helena Britt
Digital
Creativity &
DTP
Phil Henry
Design & Col
Mangmnt
Janet Best
Colour
Cathy
Treadaway
Digital
Creativity &
Craft
Susan Carden
DTP & Craft
Adrian Leak
Colour & CAD
in DTP
Garth Lewis
Design &
Colour
Robert
Burton
Textiles PaR
Aileen Kelly
DTP & Design
Education

Digital Creativity & Design Education
Bowles, M. & Isaac, C., 2012. *Digital textile design*. Laurence King.
Briggs-Goode, A. & Russell, A., 2011. Printed textile design. In *Textile Design* (pp. 105-129e). Woodhead Publishing.
Britt, H., 2012. Digital Textiles: An Investigation into Technology Utilisation, Teaching & Significance of Educator Creative Practice. *Research Journal of Textile & Apparel*, *16*(4), pp.112-121.
Burton, R., 2005. Creativity, method, & process in digital fabric printing: A 21st century paintbrush. *Digital Creativity*, *16*(04), pp.217-230.
Lewis, G., The Creation of a Virtual Colour Course.
Polston, K., Parrillo-Chapman, L. and Moore, M., 2015. Print-on-demand ink-jet digital textile printing technology: An initial understanding of user types and skill levels. *International Journal of Fashion Design, Technology and Education*, *8*(2), pp.87-96
Treadaway, C., 2007. Digital crafting &crafting the digital. *The Design Journal*, *10*(2), pp.35-48.
Textile Chemistry
Provost, John Various Contributions to Digital Textile Printing Magazine & AATCC Milson Prize in 2009
Hawkyard C 2006 *Substrate preparation for ink-jet printing in* Ujiie, H. ed., *Digital printing of textiles*. Woodhead Publishing. P201-215
Textile Technology & Industry
Dawson, T 2006 *Digital Colour Management* in Ujiie, H. ed., *Digital printing of textiles*. Woodhead Publishing. P163-178
Tyler, D.J., 2005. Textile digital printing technologies. *Textile Progress*, *37*(4), pp.1-65.
Ujiie, H. ed., 2006. *Digital printing of textiles*. Woodhead Publishing.
Colour Management in DTP
Ding, Y., Parrillo-Chapman, L., Freeman, H.S., 2018. Developing the methodology of colour gamut analysis & print quality evaluation for textile ink-jet printing: Delphi method. *Coloration Technology*, *134*(2), pp.135-147.
Javoršek, D. and Javoršek, A., 2011. Colour management in digital textile printing. *Coloration Technology*, *127*(4), pp.235-239.
Ujiie, H. ed., 2006. *Digital printing of textiles*. Woodhead Publishing.
Colour & Digital Printing in other mediums
Best, J. ed., 2017. Colour design: theories & applications.
Fraser, B., Murphy, C. and Bunting, F., 2002. *Real world color management*. Pearson Education.
Green, P., Color Management Understanding & Using ICC Profiles, 2010.
Jongerius H 2017 Breathing Colour Exhibition at Design Museum London
Parraman C, Ball, P., Clarke, M. 2013. *Colour in the making: from old wisdom to new brilliance*. Black Dog.
Digital Textile Printing from designer perspective
Carden, S., 2016. *Digital textile printing*. Bloomsbury Publishing.
Henry, P.M., 2013. *The development of a new colour-picker tool* (Doctoral dissertation, University of Leeds (School of Design)).
Kelly, A., 2014. *An investigation into colour accuracy & colour management issues in digitally printed textiles for Higher Education*. The University of Manchester (United Kingdom).
Leak, A.C., 1998. *A practical investigation of colour & CAD in printed textile design*. Nottingham Trent University (United Kingdom).

1.9 Significance, originality, and new knowledge

1.9.1 Significance

The significance of this research is that it sits between scientific and creative research and therefore has the potential to address a gap in knowledge by drawing upon multi-disciplinary research to support the design community addressing problems with colour in DTP. This target group of users often faces difficulties due to limited access to specialised colour knowledge and equipment, resulting in challenges related to achieving accurate and consistent colours in their printed designs. This research aims to empower these stakeholders to effectively address and overcome such challenges by enhancing the understanding of print-colour issues and providing practical solutions and recommendations. This endeavour holds broad implications as designers are the *colour determiners* where colours employed in their design work will significantly impact the overall achievable print-colour outcome.

There is demonstrable interest in this subject as evidenced by the number of views of a journal article published as part of the research project in the Journal of Textile Design Research and Practice in November 2020 (Gooby, 2020). At the time of submission, the article had received 4666 full text views or downloads since publication and 3 citations and is the second most read article in the journal's history indicating a significant need for research and information on this topic and highlights the potential impact of this research on the field of DTP.

1.9.2 Originality and new knowledge

This research contributes new knowledge to the field of DTP by providing a praxical investigation of colour outcomes from a designer's perspective using a methodology reflective of the designers' circumstances instead of a scientific position. The project utilises multiplicity to explore a range of fields - textile chemistry, textile technology, colour management, design education, and digital creativity rather than taking a singularity approach. This has been done by exploring and developing a modality of visual colour methods to support *'internal digital colour knowledge'* (Appendix F p103) and applying the

resulting colour knowledge in a unique mechanism for testing through the British Interwar Case Study. The project differs from existing doctoral research on DTP, including Kelly (2014), Henry (2013), Leak (1998), and Ding (2016), as it presents a praxical body of colour work investigating and exploring the impact of variables on printed-colour outcome. Additionally, the research captures the experiences of industry experts in their engagement with colour and DTP in Colour Conversations.

The inquiry culminates in an Exhibition of Praxis and an online accessible Project Tool-kit, both of which seek to offer openly accessible information to the design community, designers, creatives, and SMEs without access to specialist colour knowledge or equipment (Aim 1). The research builds on the concepts from key texts such as Tyler (2005), Ujiie (2006), Carden (2015), Treadaway (2004), Britt (2008), and Bowles and Isaacs (2009), demonstrating a novel approach to exploring the problem of printed-colour outcome in DTP. The project's key outcomes offer practical and openly accessible information to the intended audience, rather than costly courses run for the industry[3].

1.10 Outcomes and outputs

The project has produced a diverse range of outcomes and outputs. The Exhibition of Praxis and associated material provide a tangible and visual representation of the project's findings. The modality of visual colour methods, explored and developed to support designers' understanding of colour changes in DTP, seeks to offer practical tools that may be easily applied and used by designers. The Colour Conversations case studies shares insights from industry experts of the strengths and weaknesses of current textile printing practice and their experience of engaging with this technology. These accounts are invaluable to designers and SMEs in an industry that lacks best practice guidance and standardisation. The British Interwar Case Study evaluates the applicability of the project's methods in real-world scenarios. The openly accessible journal article and online tool-kit provide a platform for disseminating the project's findings and supporting designers in their work. Overall, these outcomes and outputs have the potential to make a significant impact on the DTP industry and its practitioners.

1.11 Chapter conclusion

In conclusion, this chapter has provided a comprehensive overview of the research project, highlighting its context, rationale, key findings, and the scholarly structure that guided the inquiry. The chapter began by introducing the study's purpose and significance, emphasising designers' role in determining the colours used in design work. It was proposed that visual tools and real-world test cases would address the research questions and aims.

The chapter further outlined the themes explored in the research of understanding the colour problem and tools for preparedness to highlight five significant challenges that make addressing colour in DTP problematic – gamut mismatches, numerous variables, adapted technology and processes, outsourced and remote production, and inconsistent design education and lack of industry guidance and standardisation. It also defined the research paradigm underpinning the inquiry, including the multi-modal epistemological approach of Nelson's model, and methodological framework of PaR, drawing upon a pluralist realist standpoint of colour ontology, which recognises the multiple possibilities of colour. Finally, this chapter emphasised the significance of the research project, both in terms of its contribution to knowledge and its anticipated outcomes and outputs.

The subsequent chapters will provide a more in depth exploration including expanding upon the approach – Chapter Two, the theoretical framework – Chapter Three, a review of external research, and the experimental Praxis – Chapter Four, to offer a comprehensive synopsis and analysis of the project's practical study of digital colour in textile printing.

Chapter Two

Methodology

Chapter Two provides the framework for research. By spanning a dual position between art and science, the inquiry faces two aspects of non-reproducibility, scientific and creative. The inquiry embraces an open-ended approach to colour considering multiple possibilities and reflect designers' working methods to address this complexity. A Praxis method has been employed to foster acceptance and practical application. Nelson's multi-mode epistemology structures the Practice-as-Research methodology to provide a coherent structure, and shapes the core research activities incorporating qualitative elements typical of a practitioner-research investigation. The outcome is a modality of visual colour methods aimed at improving Colour Expectation, supported by two case studies: Colour Conversations, insights from industry experts in textiles, and the British Interwar Case Study, a Colour Archive serving as a real-world test scenario to apply colour knowledge.

2.1 Introduction

This chapter presents the research paradigm which frames the inquiry using a Practice as Research (PaR) methodology, drawing from Robin Nelson's multi-mode epistemological model, and acknowledge the intricate and equivocal reality of colour and, thus, colour reproduction.

The inquiry sits between science and art with two kinds of non-reproducible dimensions. One, the scientific aspect, is that the digital textile print environment and production conditions are challenging to control, and the slightest change[4] (Carden, 2015; Gooby, 2018) may impact colour outcomes. Therefore, replication in reality becomes impossible and hence colour control is unlikely. The second aspect, the creative element, is the need to emulate the working methods and context for a designer engaging with DTP without access to specialist equipment whose printing practice will be undertaken remotely by a print bureau. This has been undertaken through the method of Praxis, creative and purposeful investigation, primarily using Computer Aided Design (CAD) and DTP, and is a non-uniform

method and therefore, difficult to replicate. The challenge posed by these specific elements suggests that investigations using a scientific approach are less suitable in this instance, due to the impossibility of replicating exact print environment and production conditions and the requirement to provide data and content which can cater to the variations of the circumstances of the design community.

These considerations, therefore, prompted the selection of Nelson's model as a scaffold for knowledge exploration due its structuring of studio-based examination, to articulation of insight through Praxis, and which lends itself to addressing the problem of colour in DTP from the designer's perspective. The model centres on Praxis *'theory imbricated with practice'* (Nelson and Arlander, 2013 p5.), where knowledge generation happens through *'thinking-doing'* (Nelson and Arlander 2013, p11.). Figure 7 illustrates the multiple modes of knowing which have been used to undertake the inquiry; Know-How, acquaintance, ability, and tacit knowledge, Know-What, propositional knowledge of what works evidenced through critical reflection; and Know-That, data-gathering and sifting of external content to navigate the complexities of colour in DTP.

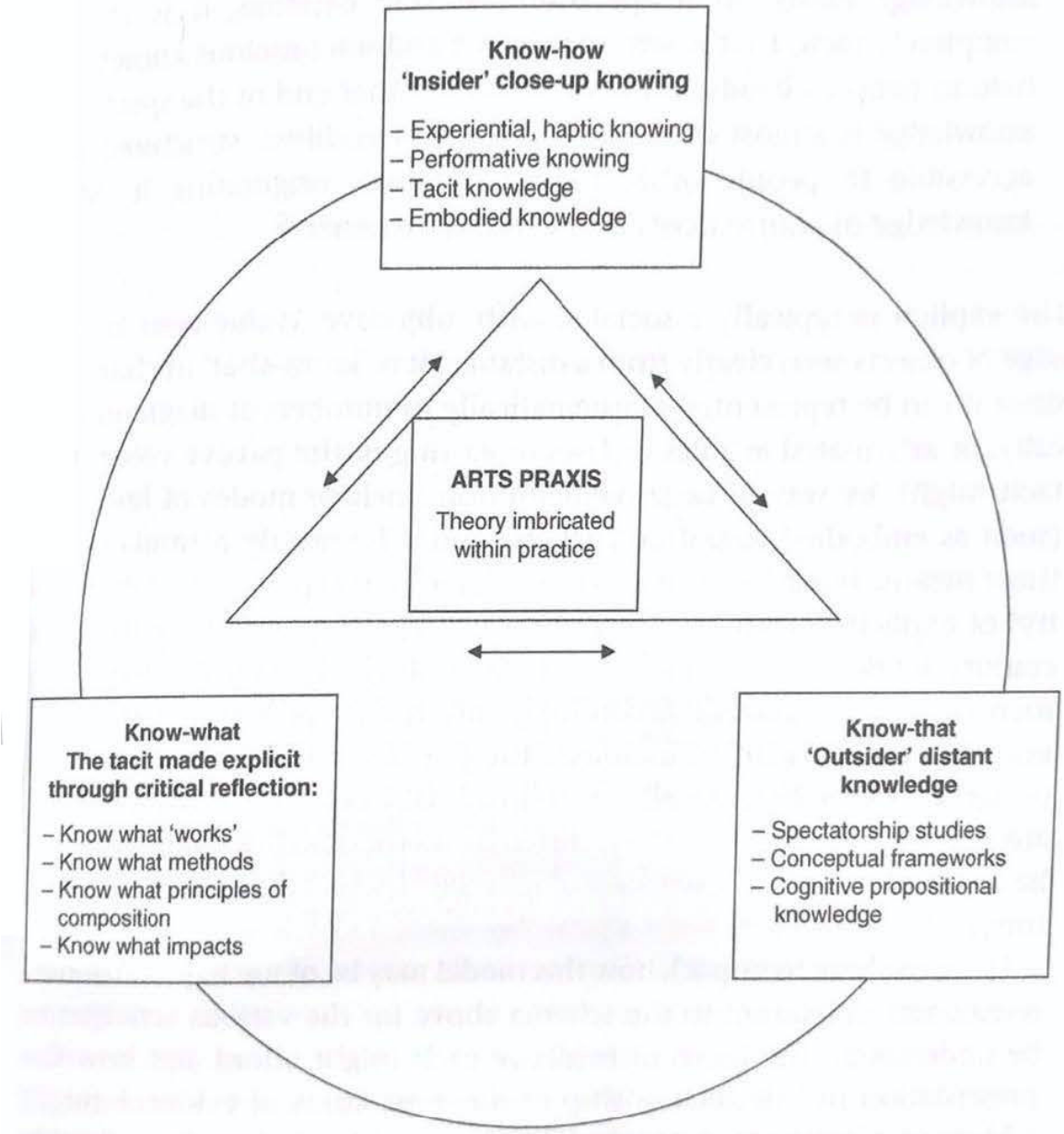

Figure 2.2 Modes of knowing: multi-mode epistemological model for PaR

Figure 7 Nelson, Robin (2013) Modes of Knowing: Multi-mode epistemological model for PaR (p37. Nelson, R., 2013. Practice as research in the arts: Principles, protocols, pedagogies, resistances. *Springer.)*

No one research method is applicable in this inquiry, and to do this project, a range of different methods have been explored, primarily praxical[5] experimentation - purposeful and creative investigation, but also observation, visualisation, sketchbooks, interviews, questionnaires, case studies and historical archival research. Each draws upon a different

approach that addresses questions around improving Colour Expectation and Colour Archive testing, to achieve the aims and objectives. This combination method approach is used extensively by practitioner-researchers to investigate and address problems in their field, for example, Laidler's exploration of the impact of changes in technology on fine art processes[6] (Laidler, 2012), Sheppy's advancing and informing of contemporary practice through traditional techniques[7] (Sheppy, 2023), and Picken's examination of the creative process[8] (Picken, 2018). Thus, multiplicity is key to a PaR approach and ensures freedom to extend beyond a singularity focus, for example, a textile chemistry, material science or colour data standpoint, and allows for symmetry where all methods are seen as appropriate and valid (Law, 2004).

However, a PaR approach is less conventional for examining colour in DTP and differs from others that have drawn primarily on quantitative and qualitative methods, for example, Ding (2016)[9] and Tyler (2005)[10], who examine colour in DTP using numerical data, qualitative content from interviews and analysis of research literature. In contrast, this studio-based PaR approach uses visual content as both a mechanism to explore the concept of colour in DTP and as the outcome, with the purpose of making knowledge more accessible to broader audiences who may not typically engage with traditional academic mediums such as journal articles, monographs, conference papers, and academic texts (Leavy 2017). This chapter, therefore, presents the PaR methodology and Nelson's model in detail, referencing the underpinning schools of thought, to demonstrate the sustaining philosophical concepts, and to provide background for fields not familiar with the concept of PaR whom this study may be of interest. It considers the strengths and limitations of a PaR approach, drawing a comparison with other associated research methodologies deployed in creative research.

The chapter moves on to outline the pluralist realist standpoint whereby colour can be understood as both subjective and objective and influenced by internal factors (subjective) – '*inthereness*' (Law, 2004 p160.) and external (objective) – '*outthereness*' (p162.) which is further detailed in Chapter Three. This stance endeavours to establish a connection between our personal experiences (Goethe and Eastlake, 1840; Matthaei et al., 1971) and the scientific investigation of the physical world (Newton, 1952). Here the inquiry presents

the choice to focus on examination of the relationship between (subjective) human colour perception and colour categorisation, based on an ambiguous human judgement (Lewis, 1997) yet an attempt at systematising colour, to understand the problem of colour in DTP and present the tools for preparedness.

Most importantly, the chapter describes the core research activities, presenting the research methods and tools used, expanding upon key experiments and qualitative elements to facilitate their replication to the greatest extent possible acknowledging that this is a challenge for nonuniform methods such as Praxis. The inquiry correlates the activities with the research questions to showcase the focus of each activity and the evidence it provides in terms of research findings.

The chapter concludes by connecting the results of Chapter Two - Contextual Review which proposes five significant challenges for achieving colour in DTP, and Chapter Four – Experimental, the development of a modality of visual colour methods, with the paradigm to demonstrate triangulation and the reflexive process.

2.2 Project overview

The inquiry was conducted in four distinct phases. Firstly, Experimentation - initial unfolding, experimental work which explored theoretical ideas, working hypotheses and production processes to gain a deeper understanding of the context of DTP. The conclusions from this preliminary activity led to the second phase, Testing of key variables, which took an identified set of variables (materials, textile chemistry, colour management and production methods) and undertook progressive and reflective exploration to assess the influence on colour impact. The selection of variables was made concerning accessibility for designers, cost, and feasibility within the project's scope. Next, a third phase, Production of methods, evolved and developed the modality of three visual colour methods considering how to visualise and convey these to designers. Finally, Articulation using a real-world test case with a specific colour palette, derived from historical archival research, as a demonstration of the application of the visual colour methods.

The body of work generated by these undertakings was formed as an Exhibition of Praxis, shown at F Block Gallery, UWE Bristol in October 2021 and restaged for the Viva examination in March 2022. The documentation of this exhibition can be found in Appendix C.

2.2.1 Incorporation of critical reflection and multiple perspectives

A key mechanism to incorporate critical reflection and multiple perspectives was peer review through critical dialogue, which occurred regularly throughout the inquiry, and is a typical technique for creative research. Critical reflection took the format of critiques - roundtable discussions and presentation of activities - with supervisors, members of Centre for Print Research (CFPR), specialist technicians, peers, and academics within the 3D3 Research Centre for Doctoral Training, of which this inquiry is part, and input from other academic experts. Figure 8 is a photograph of an early 3D3 workshop[11], which enabled opportunities to debate and substantiate tentative conclusions and preliminary inferences with peers and academics specialising in practice research. Such critiques played a crucial role in identifying strengths and weaknesses of activities and scrutinising assumptions to ensure robust examination of research. Furthermore, the inclusion of this extensive

knowledge and experience as a critical resource brought in a wide range of viewpoints, fostering an environment of constructive criticism and open dialogue to ensure that scholarly rigour was maintained.

Colleagues and scholars[12] supported the premise that visual content was pertinent and of great significance. They emphasised pursuing progressive and demonstrative experiments of colour differences which reflect the reality of the scientific aspect, uncontrollable colour, and the creative dimension, the variations and diversity of design community engaging with DTP. The undertaking of iterative calibration experiments were not raised as necessary, or considered important, within these discussions. Furthermore, academic experts' perspectives encouraged and supported using a Colour Archive as a compelling and exciting mechanism for testing and applying colour knowledge.

Figure 8 Gooby, B. (2017) Becky Gooby presenting at 3D3 training session in Falmouth

2.3 Research project plan

A timeline for the research project over four years visualising the four interlinked phases and illustrated in Figure 9: Experimentation, Testing, Production and Articulation

Figure 9 Gooby, B. (2016) Visualisation of project plan

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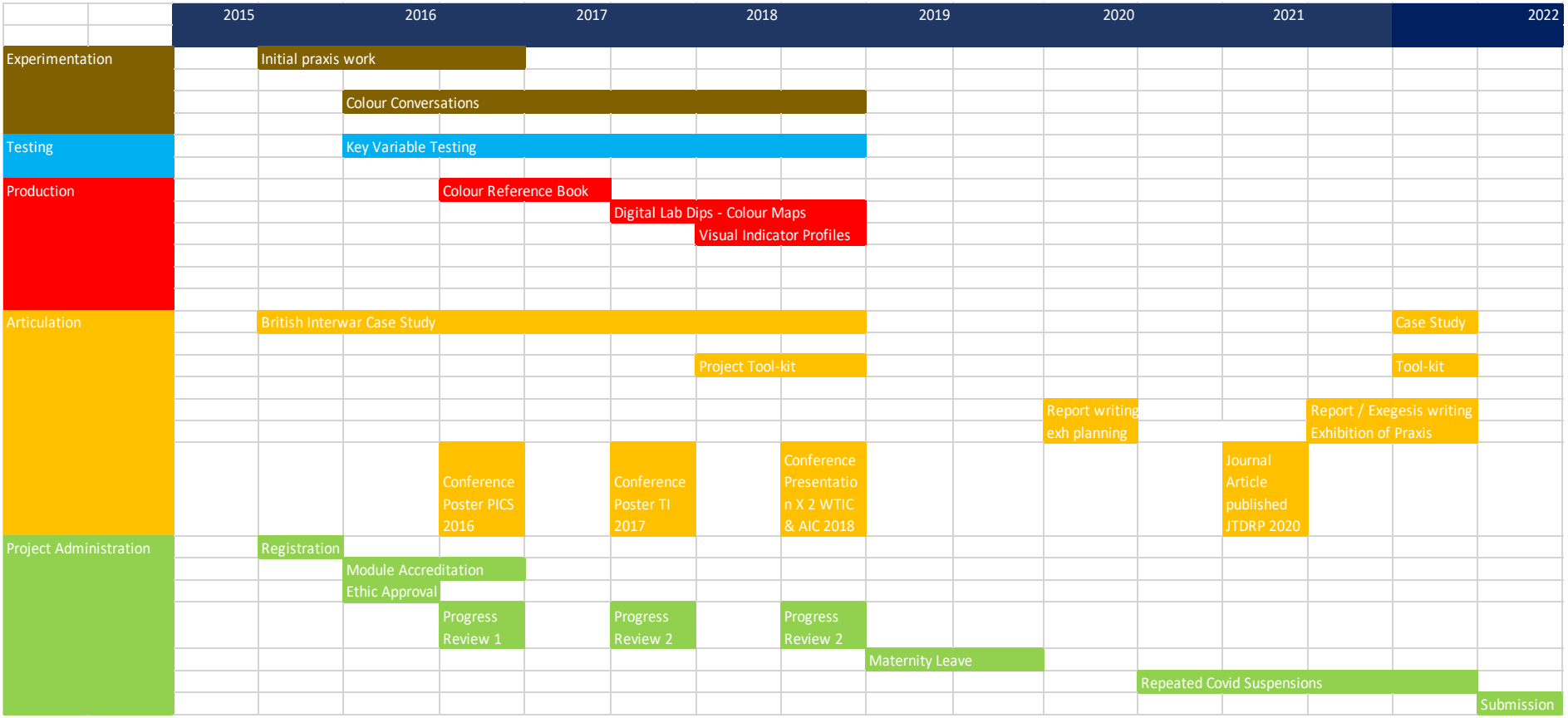

2015
2016
2017
2018
2019
2020
2021
2022
Experimentation
Initial praxis work
Colour Conversations
Testing
Key Variable Testing
Production
Colour Reference Book
Digital Lab Dips - Colour Maps
Visual Indicator Profiles
Articulation
British Interwar Case Study
Case Study
Project Tool-kit
Tool-kit
Report writing exh planning
Report / Exegesis writing
Exhibition of Praxis
Conference Poster PICS 2016
Conference Poster TI 2017
Conference Presentatio n X 2 WTIC & AIC 2018
Journal Article published JTDRP 2020
Project Administration
Registration
Module Accreditation
Ethic Approval
Progress Review 1
Progress Review 2
Progress Review 2
Maternity Leave
Repeated Covid Suspensions
Submission

2.4 Ethical considerations

Ethical approval was given to work with industry experts to achieve Objectives 2 and 3. A total of fifteen participants took part. The study recruited participants from a specific group of industry professionals and colour experts. All participants were adults with professional backgrounds and were invited to contribute their time and expertise to the project. Before the interview, participants were provided with an information form about the project and a consent form. The full transcripts and information forms are detailed in Appendix F. Interviews were conducted remotely using either telephone or video conferencing tools, and with the participant's consent, were recorded and transcribed by the researcher. The interviewees were given a copy of the transcript to review, and mutually agreed amendments made. Special considerations were given to participants with dyslexia or English was their second language. Participants were allowed to remain anonymous or use a pseudonym to address commercial sensitivity concerns. Out of the fifteen participants, only one chose a pseudonym, while the rest consented to be named. Additionally, four participants chose to complete a questionnaire instead of being interviewed. The consent form included a final date by which participants could withdraw from the study to protect the research project.

Approval was also sought to conduct user testing workshops of the Project Tool-kit with a second group of external users. However, due to the COVID pandemic these could not take place.

2.5 Practice as Research (PaR) methodology

The methodology of creative and purposeful investigation through practice was chosen as a means to reflect processes and techniques, useful to research seeking to examine colour in DTP from the designer's perspective. Further rationale for choosing PaR as a methodology was as a tool for communication as if the research method appears alien to the design community, then there is potential that research findings will not be adopted. PaR[13] contributes to knowledge generation through practical experimentation and techniques to generate content, collect data, and evaluate evidence. Additionally, the practice may be used as a mechanism to apply a theoretical framework to gain an understanding of a particular phenomenon or situation. For example, to understand simultaneous contrast laws a series of colour wheels were created using CAD, and juxtaposed onto different coloured backgrounds, which were digitally printed onto Cotton, and observations of the phenomena annotated on the prints. PaR is open to *'spontaneity, the unknown and disruption, to stimulate change and promote dialogue'* (Leavy, 2015 p19.). A key benefit of PaR is the production of accessible visual content and evidence to stimulate change beyond academia. To minimise bias and subjective interpretation, because the role of the researcher is a significant tool, rigorous and structured reflection is undertaken, and multiple perspectives are incorporated through peer review, exposition, and corroboration via literature review. Furthermore, scholarly activity such as setting aims, objectives and having a timeline with goal-orientated milestones, provides structure.

Proponents of PaR include Christopher Frayling, who in 1993 (Frayling, 1994) presented the initial framing for positioning art and design, and accepting these realms, as research practices, describing three different orientations research into, research through, and research for art and design. As recognition has grown for creative practice as a research form, various models have evolved, such as, Graeme Sullivan's 2005 *Visual Arts Knowing* (Sullivan, 2005), and the purposeful structuring from Carole Gray and Julian Malin's 2004 *Visualising Research* (Gray and Malins, 2016) and Estelle Barrett and Barbara Bolt's 2007 *Practice As Research* (Barrett and Bolt, 2014) specifically seeking to support Practice PhDs. However, others, such as James Elkins (Elkins, 2014), have voiced caution over-formulising creative research to fit the structure of the academy, highlighting concerns about hybridity

and perceptions of inarticulation from other fields where there has been academic misunderstanding around the legitimacy of practice methods. Elkins notes the challenge required to articulate the insight and process of *'nonverbal, uncognised, tacit, extra-linguistic, nonconceptual'* (Elkins, 2014 p119.) knowledge through the ambiguousness and exclusivity of text to comply with academic assessment. Nelson's 2013 PaR model, used in this inquiry, is careful, therefore, to identify mechanisms for articulation through using established and accepted modes of knowing, propositional knowledge of what works and data-gathering of external content, with a focus on reflexivity to provide distinct routes to demonstrate insight and mitigate ambiguity.

2.5.1 Strengths and limitations of Practice as Research

The strength of using PaR in this research was that it allowed for developing a naturalistic inquiry using textile design processes such as CAD, which were strengthened by incorporating concepts and principles of colour theory and DTP, to allow both practical and theoretical consideration in partnership. Circularity is encouraged with experiments in practice leading to more comprehensive investigations of ideas, which in turn, feedback into praxical tests. Nelson describes this as '*doing-reflecting-reading-articulating-doing'* (Nelson and Arlander, 2013, p.31).

An example of how circularity was used within the research can be given in relation to the exploration of variables which influence colour outcome. Experiments, using CAD and DTP, drawing on the researcher's Know-How, set out to identify variables within accessible measures for designers and demonstrate how modifying them influences the print-colour, to Know-What works. They were initiated after encountering and subsequently seeking to gain a deeper understanding of, research from different fields (textile chemistry, colour management, colour theory) in the Know-That data-gathering. Simultaneously practical exploration with software adjustments exposed by happenstance how rudimentary changes, such as printing on different substrates, impacted colour outcome. This was further corroborated by the experiences shared by Industry Experts in the Colour Conversations. These insights prompted a period of reflection where the inquiry was refined

to focus on a specific set of variables, and the Contextual Review shifted to data-gathering around these variables.

A significant reason for choosing a PaR methodology was the articulation of the research findings through the praxical outcomes, the body of colour work, which visually illustrate changes in colour. For example, the influence of altering variables. In contrast, describing the changes in text is challenging as colour language is ambiguous (Setchell, 2012), interpretation based on colour perception which is subjective (Mikellides, 2017) dependent on contextual clues including culture. Moreover, due to some of the colour differences being subtle, '*close looking'* is required (Rocamora and Smelik, 2015 p252.), which is only possible through exposition.

A PaR inquiry may be limited due to a lack of universal acceptance and apprehensions from some researchers and academic institutions, which tend to favour textual outcomes that are easier to assess, publish and collect data on (Nelson and Arlander, 2013). PaR may be viewed as subjective due to the focus of personal experience and interpretation. The haptic, playful development and nonuniform methods of practice can make it difficult to reproduce results in other settings and challenging to compare findings across studies. Additionally, undertaking research through PaR can be time-consuming. Many Director of Studies of practice PhDs warn researchers of undertaking the work of two PhDs[14] and Elkins criticises the hybridity of a Practice PhD which requires two forms of articulation – practice and text – for assessment, leading to additional work for the student. Here the selection of Nelson's epistemological model sought to counter these perceived limitations.

2.5.2 Comparison of Social Science based Action Research and Grounded Theory with the PaR methodology

PaR has evolved from adopting Social Sciences methods, which have focused on examining processes, for example, Action Research (1944) and Grounded Theory (1967), and in the absence of an established practice as research model were drawn upon by practitioners in creative research.

Grounded Theory is a qualitative research method (Clough and Nutbrown, 2012) developed by Barney Glaser (1930-2022) and Anselm Strauss (1916-1996) which aims to develop a theory or explanation from data which could include content derived from practice. It involves a systematic and iterative approach to data collection, theming, and analysis, and seeks to identify emerging concepts and relationships. Action Research, originated by Kurt Lewin (1890-1947), emphasises the practical application of research findings to address real-world problems or issues. It is popular in Education Research (Clough and Nutbrown, 2002) where it has been applied and developed by Stephen Corey (1948-) and Richard Sagor (1949-). It involves a cyclical process of planning, acting, observing, and reflecting, which allows researchers to continually refine and improve their interventions or solutions, leading to an understanding of the explored process.

This cyclical approach is comparable with PaR. However the difference is that whilst these Social Science methodologies are also concerned with exploring process, they intend to produce a theory or understanding formulated as a descriptive narrative instead of a practical visual articulation explicitly expected as a PaR outcome. Thus, PaR is a specifically formulated methodology for creative research which emphasises ways of knowing, tools, and techniques that creative researchers are familiar with in their professional practice and prioritises spontaneity, intuition, and reflexivity to capture and recognise new insight and knowledge developed as a result of creative research. Therefore, a PaR approach has been used in this research to create a unique inquiry that has allowed for multiple possibilities, and, thus, original outcomes, to offer insight different from that of a singular quantitative or qualitative methodology. For example, this project is the first to collate and test the variables that affect colour outcome in DTP and present the resulting experiments within an Exhibition of Praxis, as a key outcome. A textual comparison to this would be Ujiie's Digital Textile Printing in the Woodhead series (Ujiie, 2006b)

2.6 Multi-Modal Epistemology - Know-How, Know-What, Know-That model of Praxis

The project's PaR approach is framed within Professor Robin Nelson's established multi-mode epistemological model of Know-How, Know-What, Know-That (Nelson and Arlander, 2013). The three interconnected modes inform the inquiry in a triangulation of two-way engagement through mindful exchange and critical reflection between each mode. This is visualised as a two-headed arrow in Figure 7. Figure 10 presents a word cloud visualisation using Nelson's model to envisage the different components of knowing brought to the research inquiry.

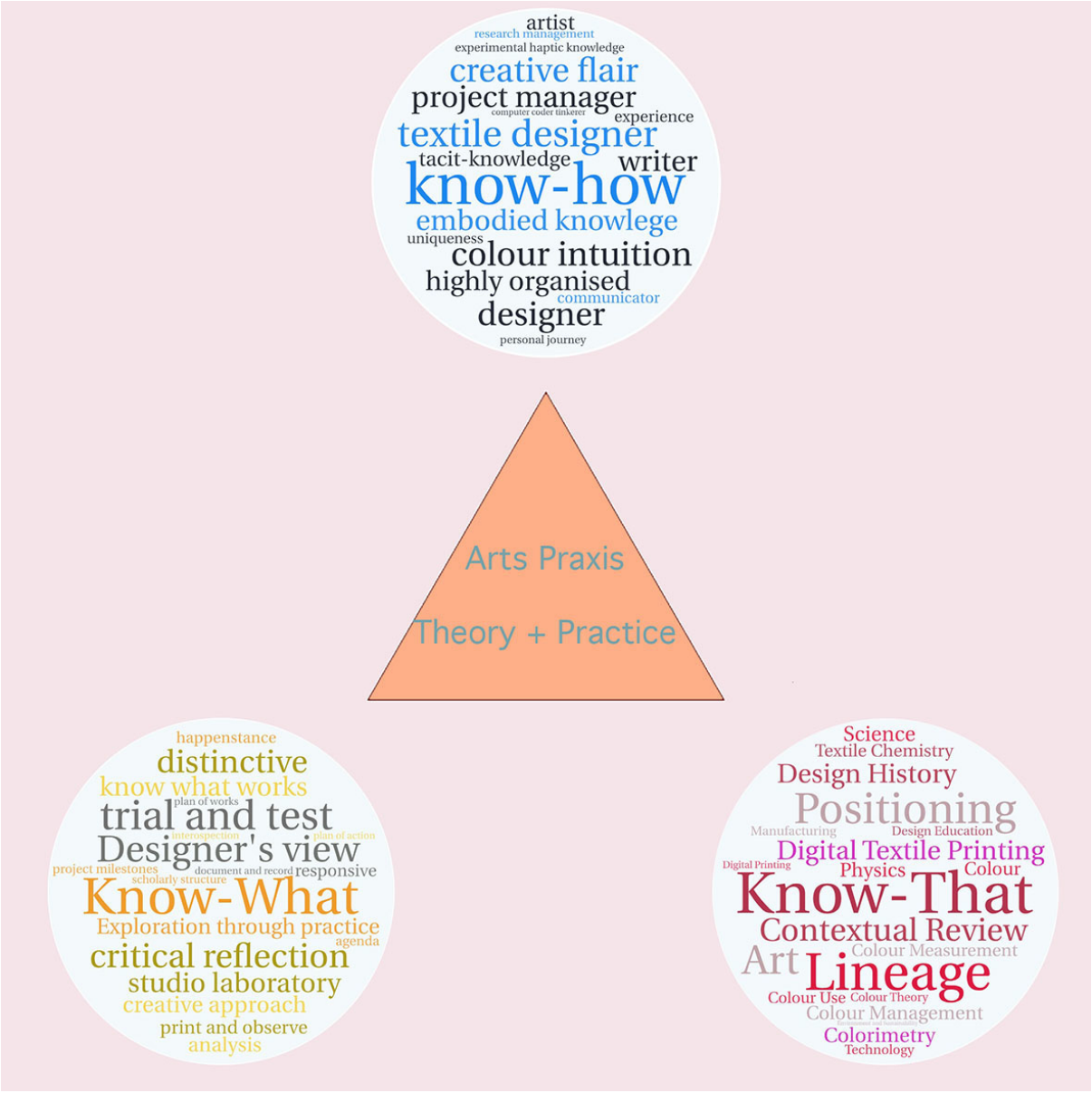


Figure 10 Gooby, B. (2018) Word cloud visualisation of the Research Inquiry's modes of knowing using Nelson's multi-mode epistemological model for PaR

2.6.1 Underpinning schools of thought

As a methodology of PaR, Nelson's model has similarly evolved from schools of thought in the Social Sciences. Key scholars, specific to Nelson's three modes of knowing are Ludwig Wittgenstein (1889-1951), Donald Schon (1930-1997), Harry Collins (1945-), and John Law (1946-). Their work encompasses the shift from universality and the concept of objectivity to argue for embracing a more nuanced understanding of the complexities inherent in reality and the messiness and intricacies of real-world phenomena.

Wittgenstein produced detailed studies on thinking and acting to counter rationalist constructs. He argued that rule-following happens through conditioning and that rules are followed mechanically (Wittgenstein, 1958) rather than due to pre-existing understandings of the rules. He concluded therefore, that rules must arise out of practice, not insight. Consequently, he stated that comprehension of reality may only be achieved by first examining its process or application rather than investigating theory. Similarly, he stated that the world consists of numerous, interwoven resemblances and connections where regularity such as social order, is imparted through practice and, therefore, does not correspond to a uniform set of activities comparable to a game with rules (Wittgenstein, 1958). As a result, examinations of reality must require methods beyond authenticating pattern to explain uncertainty and ambiguity. Wittgenstein's understandings, therefore, provide both a justification of research through practice and knowing what works, and also places huge importance on examining the process for understanding reality.

Schon sought to clarify the activity of intuition, in Nelson's model termed Know-How, reframing it as reflection and naming it *'seeing as'* (Schön, 1983 p187.). Schon proposed *'reflection in action'* as a means of initiative problem solving, declaring that investigation should revolve around process coupled with reflective dialogue. In a series of case studies examining knowledge generation within various professions, he demonstrated that reflective practice, derived from tacit understanding, was embedded within professional know-how, and moreover, was valid as an inquiry mode (Schön, 1983).

Collins takes this further with an examination of the derivation of tacit knowledge (Collins, 2005), defining it as comprising of; *motor-skills* – for example riding a bike, *rule-regression* where the convention is ambiguous, context-dependent (tradition), or multi-faceted requiring experimentation, and finally *forms of life* - bias or social conditioning. He frames this as a neural net where existing knowledge can be efficiently accessed providing a default mode. However, he states that this subjective tendency, rather than being a weakness, is a valid and vital tool because it involves not only our *'exact attention'* and *'deep understanding'* (Collins, 2005 p124.) but also necessitates '*social embedding'* (p124.) an ability that machines cannot replicate, and thus a fundamental and dynamic resource useful

for inquiry. Together, Schon and Collins justify reflexive Know-How, therefore, as a valid and robust mode of knowing.

Law argues for greater methodological variety and *'method assemblage'* (Law, 2004 p161.) proposing that as only part of reality can be captured using scientific methods, ethnography, and historical research, much of the *'hinterland'* (p160.) of the '*texture'* of reality which is *'vague…unspecific… elusive…unpredictable … intuitive'* (p6.) is lost to researchers looking for absolute truth using standardised methods in an imperfect world. Furthermore he argues that many scientific methods inadvertently influence outcomes, essentially predicting reality in a *'feedback loop'* (p33.) as a performative action. Giving the example of spectrometers, with their origin in *'yesterday's modalities'* (p30.), as perpetuating descriptions of colour as objective wavelength data, thus preserving the underlying theory and creating asymmetry by reducing confidence in other subjective methods of examination methods.

As a consequence he cautions that this limits '*new ways to see'* (Leavy, 2015 p291.) and restricts the making of partial connections between possible versions of reality. For example the perception of a visual colour change is not easily comparable with numerical colour data and leads to frustrations along supply chains when clients dispute colour matches despite supporting evidence of colour data. Law recommends that, therefore modes of knowing and research activities need to be reflexive and responsive to the complexity of *'out-thereness'* (Law, 2004 p162.) and '*multiple possible realities'* (p121.) and calls for *'allegory'* (p90.) – finding meaning between the gaps, may be considered as equally valid to finding *'explicit symbolism'* (p90.). Law's world view substantiates discovery through multiple methods, including haptic and non-uniform methods such as Praxis, which might be considered *'messy'* (p1.), to generate insight beyond conventionality, using modes of knowing formulated for creative researchers.

These schools of thought explain the shift towards the consideration and examination of process as an important approach, and validates and acknowledge process and practice, or knowing what works, and the intuitive Know-How that sits alongside it within research. Furthermore, by establishing the complexity, disorder and multiplicity of reality, these ideas support applying more than one set of values, beliefs, and methods to generate a more

profound understanding and insight. PaR and Nelson's model are an evolution of these ways of thinking, which places specific importance on the value of practice and the non-textual as novel mechanisms and outcomes for research.

2.6.2 Examples of usage

Given its roots in performance[15] and Nelson's expertise in media and television, it is unsurprising that Nelson's model has predominantly been applied within performance studies, finding it particularly valuable in transient and ephemeral practices. Moreover, doctoral studies in various domains, including dance, music, drama, and the visual arts, have successfully employed this model[16].

The three modes of knowing

2.6.3 Know-How

The central notion of Know How is that the direct physical experience of the practitioner enables them to take on a unique dual position of specialist coupled with the analyst (Sullivan, 2005) to showcase the researcher as a creative investigator, bringing both tacit skills and strategic knowledge to cultivate a perspective of professional expertise through a reflective thought process (Mottram, 2009). Thus, this inquiry has sought to demonstrate how the researcher has worked with the materials differently than a scientist or engineer would (Maeda et al, 2013). It, therefore, documents the researcher's personal journey and professional expertise not only as a preface to the project, but also to highlight the techniques, skills, and experience of working as a designer, which inform the inquiry. Nelson terms this as *'procedural knowledge'* (Nelson and Arlander, 2013 p41.) drawing on Schon's concept of '*knowing-in-action'* (Schön, 1983 p49.) He acknowledges the inherent difficulties in clearly expressing the knowledge derived from prior experience and therefore, this mode of knowing is often implicit and requires signposting. Furthermore, Know-How can be subject to accusations of subjectivity and, therefore, it is important to include transparency about personal influences and mitigate bias. Nelson's model does this by including multiple perspectives through the mode of Know-That and incorporating critical reflexivity through-out the inquiry as part of the Know-What. For example, reflective journaling and encompassing peer review. The use of Know-How is prefaced in p.24 and signposted in p85.

2.6.4 Know-What

Nelson describes this as propositional knowledge or the *'know what works'* (Nelson and Arlander, 2013 p.44) and is knowledge derived through practical experiments and hands-on application that are exploratory and investigative and may evolve through happenstance, reflection or hypotheses and theory testing. Here, as Dobson notes, *'the importance of playing with materials to truly come up with something new'* is paramount (Maeda et al,, 2013 p143.). It is articulated and formulated through informed, critical reflection *where 'the moments when things begin to work'* (Nelson and Arlander, 2013 p44.) are captured and identified, for example annotating prints, analysing documentation, recording, and reflecting on experiments. It requires cognisant observation and reflection from the researcher, drawing on their Know-How and contextual knowledge to determine what is working, and corroborating that with outsider and multiple perspectives. Chapter Four, Experimental, presents the unfolding of the Know-What knowledge, and p.76 onwards, provides a synopsis of the implications.

2.6.4 Know-That

Nelson uses this extended or outsider knowledge to capture the traditional *'propositional discourse'* (p45.) typically evaluated in a literature review. Here, Chapter Three, Contextual Review, filters and summarises this knowledge. The term contextual has been used, as prescribed by Nelson, rather than literature, because it includes content beyond textual and numerical resources, including observations from exhibitions, commentary on practitioners, and assessment of design tools.

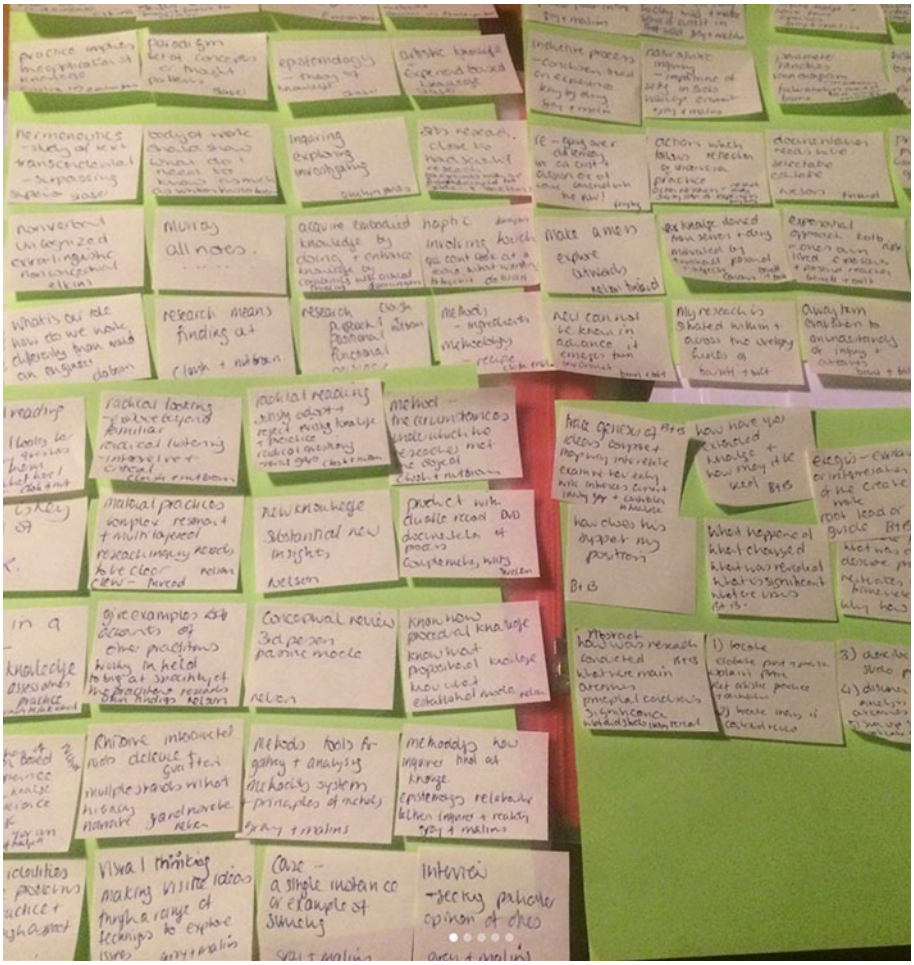


Figure 11 Gooby, B. (2020) Image documenting the working practice of researcher using post it notes to highlighting key ideas and thoughts encountered during Contextual Review

The Know-That informs the praxical Know-What, and enhances the researcher's Know-How, in a state Nelson describes as '*liquid knowing'* (p48.). An example of how the inquiry sifted this data is shown in Figure 11 where an exercise was undertaken to create short notes summarising ideas and propositions, using handwritten post-its to cultivate cognitive discipline and employing the motor skills of writing to promote the assimilation of knowledge. Importantly it provides content beyond the researcher's immediate experience and direct observation to bring multiple perspectives, create interactive knowledge exchange, scholarly rigour and mitigate the subjectivity of the researcher's positionality. Equally, it situates the inquiry within the lineage of related research conducted in the immediate and broader field. In his model, Nelson emphasises including the work of practitioners within this mode of knowing to interconnect the three modes. So, the research

has explored practitioners' approaches to consider multiple expressions and descriptions of colour.

2.7 Colour Ontology

The study continues to acknowledge the complexity and interplay of the research's non-reproducible scientific and creative aspects. It has undertaken a review of philosophies that seek to determine the nature of colour and colour reproduction. These are presented in p133. Here, the inquiry's understanding positions that there are multiple possibilities of the reality of colour taking a pluralist realist perspective (Lewis, 1994; Matthen, 2005) to recognise that colours may have objective and subjective components, and may be explained, or described, using both phenomenological and explanatory approaches. In that colour may be experienced as (subjective) an idea of colour which is both perceptual and contextual, and as (objective) a secondary quality, in relation to the property of an object.

Furthermore, the inquiry acknowledges that colour may be influenced by the relationship between the object and perceiver, shaped by the interaction between the properties of the external world or *'out-thereness'* (Law, 2004 p162.), and the perceptual processes of the observer, *'in-thereness'* (p160.), a relationalist stance (Cohen, 2004).

The stance is helpful for investigating colour in DTP because of the multiplicity of the domain of research which covers broad fields of textile chemistry, colour management, art and design and printer technology, all of which draw on different realities and elements of colour, subjective and objective. Here a focus has been made on the phenomena of human colour perception and colour categorisation, to contribute to our understanding of how by individuals and societies perceive, organise, and represent colours.

Thus, the inquiry focused on examining (subjective) human colour vision and (objective) replication in computer colour vision, as well as colour idiosyncrasies such as metamerism which affect colour perception. It looked at systems used to quantify colours such as colourimetry, spectrophotometry and colour management, and methods of colouration in conjunction with materiality, for example colourants and textile substrates. Additionally, it examined the conscious endeavour to systemise human colour vision through colour categorisation, in terms of grouping and assembling colour to aid communication and understanding. Here the inquiry explored the formulation of colour spaces, colour models and colour systems which aim to arrange combinations of colours, for example blends and

harmonies, to enhance practical application. Examination has been through theoretical assembling, praxical experimentation of theories and concepts, reviewing examples of tools, devices and techniques that deploy these theories and reviewing examples of practitioners exploiting these theories. Summaries of this examination is interwoven in Chapter Three – Contextual Review which presents the Know-That mode of knowing to understand the colour problem and the tools for preparedness.

The subjects outlined above are indeed not limited to a specific discipline or this inquiry. Therefore an inquiry into the demonstration of colour differences and exploring methodologies to improve colour expectation has the potential to have implications that resonate within the design community, and beyond. Therefore, this chapter has sought to provide a comprehensive overview of the reasoning for selecting the research paradigm, as well as elaborating on the substance, to provide information to those not accustomed to creative, less structured, strategies for research, before presenting the research activities, methods, and tools.

2.8 Methodological overview of the Core Research Activities

The following section describes the research activities and outlines the connection to the aims, objectives, and research questions. The intention is to record each piece of work and situate it within the narrative.

Complementary to scientific methods[17], PaR primarily employs Praxis as method for research. This nonuniform method poses challenges in terms of repeatability due to its dynamic and exploratory nature (Brabazon et al, 2020). Indeed, Law notes that even accounts of methods which are *'clean and reassuring'* hide *'ragged ways in which knowledge is produced'* (Law, 2004 p18.), arguing that all methods should be *'tools for discovery'* (Law, 2004 p38.). Replicability should not denote their authenticity. Thus, whilst scientific testing under precise conditions, where one parameter is altered and the results evaluated, are utilised in research for examining colour in DTP, this is not a typical approach for a designer. This could be seen as a limitation but represents the reality. Future work as a result of the inquiry, would, require however, iterative variable testing to refine and develop the proposed techniques.

Hence, the strategy taken here is first to provide a visualisation of the multiple methods deployed in the inquiry to demonstrate the multi-modal epistemological approach and, to avoid repetition with Chapter Four, provide an outline, and examples of usage in a separate Appendix B, for those unfamiliar with creative research methods. The visualisation is followed an outline of the tools and settings utilised to provide detail about what content was captured, and what wasn't. This is followed by a synopsis of the core experimental activities, Praxis from the production phase, and the qualitative elements - Colour Conversation Case Studies (Interviews) and British Interwar Case Study (historical archival research). The activities are presented in reference to Chapter 4 which goes into greater depth with a step-by-step description. Due to their preliminary nature and to keep the focus on the core activities, initial more exploratory experiments and activities which examined the influence of key variables, are described only in Chapter 4 but remain acknowledged in the research narrative.

2.8.1 Visualisation of methods and analysis

Figure 12 visualises the methods deployed by the multi-modal inquiry with reference to Appendix B, as many are non-uniform and not standardised. Practical implementation is then described from p.76, and technical specifications outlined in Table 3 and Table 4.

Figure 12 Gooby B (2022) Diagram of methods and analysis

Photography & Video Documentation
Reflective Blog
Sketchbook
Audio Reflection
Reflective Journal
Quantitative Data Gathering & Analysis
Visualisation
Visual Analysis
Case Study
Praxis
Reflective Analysis
Historical Archival Analysis
Qualitative Research Methods
Critical Analysis
Comparative Analysis
Interviews
Observation
Discourse Analysis
Visual Observation
Indirect Observation
Peer Review
General Direct Observation

2.8.2 Tools for Research

To conduct the research the following tools, software and materials were utilised and to aid replication are listed in Table 3. Some of these captured core research data and are so technical settings are provided in Table 4 below.

Research Activity	**Software**	**Machinery**	**Other**
Colour Conversations Case Study	**Transcription software** (Express Scribe) **Audio Recording Software** (QuickTime) **Audio Communication** Tools (Skype, Facetime, Telephone) **Email Communications** **Word Processing** (Microsoft Word)	Dictaphone MacBook Pro 1 OS X 10.11: El Capitan (Gala)	
Praxis Work and British Interwar Case Study	**Computer Aided Design Software** (Adobe Photoshop Creative Cloud (APCC) 2015 and APCC 2020, ACA CAD CAM textile design software including Printer Cal for profiling and ColourSys for colour palettes) **Word Processing** Microsoft Word **Quantitative Data Processing** Microsoft Excel **Reflective Journal** Microsoft PowerPoint **Colour Data Software** Pantone Colour Manager **Audio Communication Tools** (Skype, Facetime, Telephone) **Email Communications**	**Digital Ink-jet Textile Printer** Mimaki TX2-1600 Digital Ink-jet Textile Printer with Reactive Dyes (Cyan, Magenta, Yellow, Black, Light Cyan, Light Magenta, Red, Orange, Blue and Grey) **Spectrophotometry Equipment** Kodak Minolta FD7 Spectrodensitomer set up to return LAB colour data using D65 light conditions, iProfiler Spectrophotometer to return and iProfiler 2 Spectrophotometer using D65 light conditions **Other printers** Xerox PrimeLink C9065 – paper printing Epson SureColour P9000v - paper printing	**Textile Substrates:** Silk Satin, Wool Twill, Cotton Satin, Juniper Linen – purchased precoated from Whaleys.co.uk Silk Satin, Wool Twill, Cotton Satin, Juniper Linen purchased uncoated from Whaleys.co.uk

	Colour Systems, Models & Spaces in APCC Pantone Solid Uncoated Colour Library HSB Colour Model CIE Colour Model CIE LAB Colour Model Other profiling software iProfiler **Social media** WordPress and Instagram	Epson Stylus DX800 – for textile printing using postage labels **Documentation** NIKON D90 Camera – for documenting practical experiments **Visual Observation** Veri Vide CAC120 Light booth for Daylight, D65, D55 and artificial light settings for observations, Nikon SMZ800 Digital Sight Microscope and corresponding NIS Elements software to look at samples and dot matrix **Other Machinery** Star Hanging Steamer @ 100 Degrees C, Liquor Ratio 1:1 Zanussi Washing Machine – 30 min cold wash with colour catcher **Reflexivity** iPhone – camera and voice recorder MacBook Pro 1 OS X 10.11: El Capitan (Gala) MacBook Pro 2 macOS 12: Monterey (Star) Nifty Portable Data Storage 1TB External Hard Drive Seagate Back Up Plus 10TB using Mac Time Machine	

Table 3 Research tools and equipment used by the inquiry

Further Technical settings for the core tools for data capture

Mimaki TX2-1600 Digital Ink-jet Textile Printer Drop on Demand

Media Settings Colourant Set: Mimaki Reactive Dyes (Cyan, Magenta, Yellow, Black, Light Cyan, Light Magenta, Red, Orange, Blue and Grey) RIP: AVA V4.5 8 Bits. Profile Settings: Bespoke Profiles for Textile Substrates Wool, Linen, Cotton, and Silk. Profiles created annually by Digital Print Centre Technicians using 1748 Colour Target and AVA Profiler with iProfiler Spectrophotometer using D65 light conditions Shrinkage rates were set per fabric: Wool 10%, Silk 5%, Cotton 2%, Linen 2% Images: Flattened JPEG and TIFF File Format at 250 dots per inch. Textile Substrates as per Table 3 **Data produced:** Digital ink-jet printed textiles using set up above onto pre-purchased pre-coated natural fibres. **Data not captured:** The printer was not able to account for textile chemistry or textile characteristics, bar estimated shrinkage settings. The printer was not able to provide data on user preferences, colour outcome or ascertain print defects. The printer was not able to provide data about different colourant types or non-natural materials. This tool was appropriate for an inquiry seeking to investigate colour outcome in DTP because it enabled the production of digitally ink-jet printed textiles a key part of the praxical activities.
Kodak Minolta FD7 Spectrodensitomer set up to return LAB colour data using D65 light conditions Using IProfiler and Pantone© Colour Manager Software **Data returned:** Colour Data- CIE LAB, Spectral Data- Wavelength data (400nm-700nm) and Colour Data - Pantone© References **Data not captured:** Ink density, Surface Texture, Print Defects, Colour Gamut Expectation (Screen colour to print colour) This tool was appropriate as it provided colour data and spectral data for analysis in a format that could be understood by a designer with some instruction and context which allowed a comparison with visual observations and underpinning data for visualisation.
iProfiler Spectrophotometer and iProfiler 2 Spectrophotometer using D65 light conditions when measuring textile prints and D55 light conditions when measuring paper prints Using IProfiler and Pantone© Colour Manager Software **Data Returned:** Colour Data- CIE LAB , Colour Data - Pantone© References **Data not captured**: Ink density, Surface Texture, Print Defects, Colour Gamut Expectation (Screen colour to print colour) This tool was appropriate for the reasons listed above for the spectrodensitometer. It also allowed for spectrophotometric-colour profiling which supported the praxical activities.

Table 4 Further technical settings of core Praxis tools

Core Research Activities

The following section describes the different experiments carried out and the methodologies involved, so that the reader may understand and seek to replicate them, with reference to p73 and Chapter 4. Nelson's model is signposted with a section on the Know-How, with Chapter Three – Contextual Review and Chapter Four- Experimental presenting how the Know-That and Know-What modes of knowledge were applied.

Additionally, Appendix B, p6-32, contains the synopsis record for each activity and the outcomes which consolidates the three modes of knowing with the research questions, aims and objectives.

2.8.3 Qualitative Work – Colour Conversations – Exploration and Testing Phase

RQ1 and RQ2 - Addressing Research Questions on Colour Expectation

In order to address RQ1 - *What measures must a designer take to feel confident with their colour use in digital printing on cloth?...* And RQ2 - *How can scientific colour theory and production methods for digital printing be understood and utilised by the design community?*... Objectives 2 and 3 were undertaken to analyse the designer's needs, and to gain an understanding of the current state of the design environment. The research methods used 1) Interviews and Questionnaires 2) Case Study 3) Reflective, Discourse and Comparative Analysis.

These methods gather in-depth information and understand multiple perspectives enabling the inquiry to introduce context to the inquiry with valuable and credible examples of real-world experiences of colour and DTP of industry experts in the textile industry. This was important to the inquiry to mitigate bias, and bring multi-faceted input, following Nelson's model, contributing to the Know-That mode of knowing.

To achieve Objective 3, *Co-ordinate a network of experts to facilitate a series of case studies, titled "Colour Conversations",* fifteen purposeful conversations with industry experts were undertaken which focused on achieving Objective 2, *Use interviews and case studies to identify the strengths and weaknesses of current textile printing practice by gaining and understanding of the experts' views and their experience of engaging with DTP*. As an

interpretative position these interviews are presented as case studies, comprising a formal collection of evidence presented as short summaries and a set of themes.

The selection of experts from the textiles industry, was sampled from trade shows, design studios working with DTP, DPS, HEIs with DTP facilities, key academics working in DTP, and own professional and personal contacts. It proved tricky to secure agreements to participate in the research, particularly when commercial sensitivities were involved or when individuals had limited availability or willingness to allocate their time. Therefore, the conversations happened over an extended period of time than planned, and took the form of singular instances rather than multiple occurrences as envisaged. Interviews were conducted remotely using telephone and video conferencing tools. p55 details ethical considerations.

The interview transcripts were reviewed and analysed by the researcher, and pertinent text was highlighted and timepoints noted. Pertinence was defined as corroboration of working hypotheses (Appendix B), examples of challenges in achieving colour matching, solutions trialled, examples of standpoints, examples of benefits of DTP and corroboration of Know-That knowledge encountered through Contextual Review. The analysis was combined into a summary for each transcript, which additionally included biographical information about the participant. Questionnaires were reviewed and colour coded according to whether the response was about the participant's experience, or whether it was about the experience of students at the HEI they worked at. Each questionnaire was summarised by the researcher to identify the strengths and weaknesses of DTP according to the participant as well as providing information on design education with regards to colour in DTP.

The principal method was interview, supported by a questionnaire where participants were not able to provide much time. Additional methods used were transcription and a reflective journal. Tools used as per Table 3. There were several periods of critical reflection to evaluate and monitor progress including preliminary reflection over ethical considerations (writing information documents and consent forms and gaining approval), consideration of the question material and formulation of questionnaires, audio Reflection through-out the process, internal reflection over the selection of the interviewees, audio reflection during

the transcription process and analysis of Colour Conversation series for themes, variations, and alternate experiences.

The content was integrated into the inquiry through a shift in the focus to testing key variables, as the industry experts highlighted that controlling variables, in particular substrate was a mechanism to improving colour expectation, as well as identifying textile chemistry and colour management as areas that had a great impact on colour outcome. The study also provided evidence that visualising colour differences would be beneficial to assisting designers.

From these interviews and evidence, a set of themes were proposed, p123, and the work was subsequently summarised, and peer reviewed at a poster presentation at Textile Institute *Textiles and Life Conference*, Manchester UK, in November 2017. Full material can be found in Appendix F.

The Colour Conversations support the proposition by the inquiry that there are five significant challenges to colour in DTP, highlighting the complexity of the gamut mismatch between the screen and the print, drawing attention to the difficulty of navigating numerous variables, in particular textile chemistry and colour management, which amplify the compromises made from adapting reprographics technology and traditional colouration processes. The case study content further underscores the problems that have arisen from the lack of understanding of the underlying principles of colour in DTP, due to inconsistent design education, lack of industry experience and industry guidance and standardisation, compounded from it being an outsourced process, remote from the designer.

2.8.4 Praxis Work - Core Activities - Production Phase

RQ1 and RQ2 Addressing Research Questions on Colour Expectation

In order to address RQ1, *What measures must a designer take to feel confident with their colour use in digital printing on cloth?...* and RQ2, *How can scientific colour theory and production methods for digital printing be understood and utilised by the design community?*, a range of praxical (technical and scientific) experiments were undertaken to achieve Objective 1*, Survey and compare different digital colour printing systems for textile*

designers and Objective 4, *Establish a coherent body of colour work using digital textile printing*. This work, coupled with the qualitative work outlined above, sought to provide the underpinning knowledge and content to achieve Aim 1, *To develop a tool-kit, that is accessible to artists, designers, and SMEs without access to commercial resources and chemical colour knowledge/science, which provides guidance to improving a colour match when printing from digital printers on to fabric.*

As a result of preliminary work[18] three key activities developed resulting in a modality of visual colour methods to address RQ1 and RQ2.

Modality of Visual Colour Methods

Colour Reference Book

The outcome of this research activity is a bound swatch book of 1137 Pantone Solid Uncoated Library Colours digitally printed on four substrates (wool, linen, cotton, silk) and a comparative paper print. A set of colour data (RGB, CMYK, LAB, HSB and #) is recorded next to each set of swatches. P.165 presents this work in further detail.

An example of Praxis includes CAD to create 1137 10x10cm 300dpi digital JPEG files, for each Pantone reference in order to be representative of the Pantone Library, using a colour picker tool in APCC design software for DTP. To support the principal method of Praxis, various other methods were used including Observation, Quantitative Data Gathering and Analysis of Colour Data – using Spectrophotometry and numerical median measurements, Documentation - Photography and Film, Reflective blog, Reflective and Visual Analysis and Peer Review. Visualisations included line graphs and histograms, compiling contact sheets of digital CAD files, annotating prints with visual observations and note and drafting in sketchbooks, as well as Audio Reflections recorded at the end of each step to determine actions for the next stage. Printed swatches were observed under different light sources (daylight and artificial light) using a Veri Vide CAC120 light booth.

These methods gather first-hand experience and contextual understanding through practical application of ideas complemented by the systematic exploration of visual colour

changes and examining quantitative data to incorporate subjective and objective approaches to describing colour differences and forecast predictions of colour changes. This enabled the inquiry to compare visual screen-to-print-colour differences and further alterations between substrates alongside colour data for a large set of hues. It forms part of the Know-What mode of knowing, underpinned by the Know-How.

The work was integrated into the inquiry as a development of the production phase, and further applied in the articulation phase. It was presented for peer review and exposition on multiple occasions to corroborate and verify visual observations made by the researcher. Additionally, the work was exhibited at the DataAche Conference, Plymouth University in September 2017, as well as at the Exhibition of Praxis in October 2021 and the Viva examination in March 2022.

It must be acknowledged that there are limitations of this work. The Society of Dyers and Colourists recommended swatch size is 4cm by 4cm, backed on grey card. However, in this case, the swatches were printed smaller (2cm by 2cm) and backed on white, mainly to reduce printing costs and due to a lack of awareness of the recommended standard at the time. It's important to note that the swatches provided only a single example rather than a comprehensive representation of printers, colourants, and substrates reflecting the reality of the non-reproducible scientific and creative aspect. Additionally, only one set of swatches was compiled, and the process was not repeated due the significant time investment it required and costs. As a result, the observed colour differences may vary if reprinted or using a different print environment. Visual observations were made by the researcher and whilst corroborated by critique and exposition, are subjective.

The work demonstrates the key challenges of gamut mismatches, numerous variables, and adapted technology by evidencing the differences between the colour data of the 5 different colour spaces, and visual differences in the colour swatches, which as the characteristics of the different fabrics and dyes are not accounted for, and the samples are ink-jet printed, using a drop on demand technique, represent the difficulties of using adapted technology for DTP.

Digital Lab Dip Tests – Colour Maps

The outcome of this is activity is a set of digitised colour swatches and a corresponding series of colour maps representing Hue, Saturation and Brightness shifts between the screen-colour and printed outcomes. The digitised swatches were created by measuring two sets of physical swatches in the Colour Reference Book using a spectrophotometer and recording the LAB data which was entered into APCC to form a digital lab dip test. The colour sets comprised of the first 24 hues of the Pantone range, a spectral range of highly saturated colours, and 24 hues from a colour rendition chart – a set of essential colours based on colour system primaries and colours that are challenging to reproduce. The work is digital with physical prints of the colour maps. This work is further detailed from p176.

Example of Praxis includes using CAD to create a HSB colour map in APCC and colour picker tool to create digital swatches using measured CIE LAB data converted to HSB in APCC. To support the principal method of Praxis, various other methods were used to gather, and enable, content and integrated as per Colour Reference Book. Additionally, the Quantitative Data Gathering and Analysis incorporated spectrophotometry-based colour profiling to generate objective colour data from measuring the printed swatches so that they could be digitally captured. As well as exposition at the DataAche conference, the Colour Maps were exhibited at Gallery Kopio, University of Lapland, in September 2017 with accompanying peer review and critique, as well as an exposition at Bower Ashton Campus, UWE Bristol, October-December 2017.

It is important to acknowledge the limitations of this work as the colour measurements used in the analysis represent a single instance of printed-colour outcome since the experiment was not repeated due to the significant time required to carry out the activity. Furthermore, to accommodate the project's timeline, the number of Pantone© hues analysed was reduced from 1137 to two data sets, resulting in 48 hues being examined. During the conversion process from LAB data to APCC, there was a loss of accuracy due to rounding the input data to fit APCC's requirement of whole numbers. These reflect the reality of the research and future work would undertake iterative, calibration experiments to refine techniques.

The work demonstrates the key challenges of gamut mismatches, numerous variables, and adapted technology in that the colour data presents the differences between the RGB and CMYK colour spaces for these 48 hues, the observed colour differences and colour data differences for the four textile substrates present the challenge of colour matching across key variable – substrates, and finally the visual colour difference between a more minor shift of the paper prints with the screen hue in comparison with the shift of the textile prints demonstrate how this technology has been developed and refined for colour outcome in paper printing and does not accommodate for the characteristics of textiles.

Visual Indicator Profiles

The outcome of this activity is set of iCC profiles which create experimental and indicator colour changes when applied to an image on screen. The profiles were developed from altered colour targets which were measured using AVA CAD CAM Printer Cal to generate a profile. The targets were altered using data gathered from analysing colour differences between screen and print outcomes in the Colour Reference Book. Digital files use ICC profiles to convert colour data between devices such as computer screen to printer. The profile translates colours, not found in both devices' colour spaces, to an alternative, dependent on the print environment. The work consists of a set of digital .icc files. Full detail is provided from p193.

An example of Praxis includes using CAD to alter 1748 colour targets using numerical median colour differences to represent printed colour changes by substrate characteristics, the undertaking of spectrophotometry-colour profiling using the altered colour targets to produce icc profiles in AVA profile maker, and CAD to create collage textile design for assigning icc profiles. As per Digital Lab Dip tests multiple methods were used to support the Praxis, to gather, and enable, content and integrated the activity to the inquiry. The profiles were presented for peer review and critique at paper presentations at the Textile Institute World Conference, University of Leeds in July 2018 and at the AIC Interim Meeting, Lisbon Portugal in September 2018, in addition to the Exhibition of Praxis and the Viva examination. Furthermore the work became part of a separate project, *Ways of Making* as an application of colour knowledge with the work of Sir Peter Blake, and displayed at the

Royal Academy, London and at CFPR 21st Birthday Exhibition, UWE Bristol June 2019, and in a published article in November 2020[19].

It is important to acknowledge that the profiles were generated in a specific print environment and that whilst the researcher tested the indicator profiles on different monitor displays, they have not yet been subjected to testing by external users as workshops had to be cancelled due to the Covid Pandemic and iterative, calibration experiments would be required to make refinements.

The work demonstrates the key challenges of gamut mismatches, numerous variables, and adapted technology by specifically exploring the differences between the screen gamut and an indication of the printer gamut for Textile Substrates. It evidences the impact that the key variable of Textile Substrate has by indicating on the screen the expected colour change of printing on Textile Substrates (wool, linen, cotton, and silk), emphasising the challenge of using adapted technology which does not account for textile characteristics.

Signposting the Know-How informing Colour Expectation

The foundational knowledge derived from this mode of knowing is presented next to mitigate bias, ensure transparency, and triangulate the Know-How - ability, acquired and tacit modes of knowing

As a design professional, the researcher knows the textile industry and consequently has an understanding of the way designers and design studios utilise colour (for example, colour tools, colour communication) and therefore was able to communicate effectively with the industry experts about the issues they faced, comprehending their experiences. Her educational background (fine art and design) ensures she has a comprehensive and creative approach to colour and no known colour vision issues. The researcher uses Pantone© and APCC in her professional practice and so was able to utilise these tools to develop the modality of visual colour methods. Furthermore, having undertaken an investigation into the history of the colour diagram which assessed the range of colour diagrams and their uses, was able to draw upon this information to underpin the development of the visual colour methods – in particular the colour maps - and consider how to visualise colour

differences. The researcher has experience and training in visual analysis and reflective research, as well as undertaking specialist Colour Management training which included use of spectrophotometers and profile creation. Additionally she received AVA CAD CAM instruction. The researcher drew upon practical and creative approaches as well as conducting a Contextual Review, to understand basic laws and concepts from the fields of textile chemistry, colour management and colourimetry.

2.8.5 Qualitative Work - British Interwar Case Study - Articulation Phase

RQ3 and RQ4 – Addressing the Research Questions on the Colour Archive

The outcome of this work is a Case Study comprising of a formal collection of a body of colour work (samples books, annotated prints, digital Adobe Swatch Exchange -.ase - files) and text detailing the generation of the colour palette from historical archival research and application of colour knowledge using the modality of visual colour methods. This is complemented by a historical literature survey of colour used in the British Interwar period. The research activity was conducted using several methods 1) Historical Archival Research 2) Literature Review 3) Praxis 3) Case Study 3) Reflective, Visual and Comparative Analysis. This activity is detailed from p203.

An example of Praxis include CAD to create textile designs in APCC and applying .ase colour swatches to create variety of colour ways in AVA CAD CAM design software. To support the method of Praxis, various other methods were used as per the Colour Reference Book and in addition to the case studies and the historical archival research. These methods gathered narratives and insights from primary sources and were used to provide content as a tool for communication and assessing practical application in keeping with Nelson's multi-modal model as a structure for articulating creative insight. The work was integrated into the inquiry as an application of colour knowledge in the articulation phase as a tool for communication and an evaluation of practical benefits and applicability of the modality.

In order to achieve Aim 2, T*o create a historical digital colour palette and address questions around Colour Archive*, RQ3, *How can historical colour be used to inform colour aesthetics in digital textile printing?..* and RQ4*, How did colour use develop in the British domestic interior*

of the interwar period? …, Objective 5, 6 and 7 were undertaken to formulate a real-world case study as a mechanism for applying the modality of visual colour methods.

To achieve Objective 5, *Undertake a historical literature survey on the colour palette in the British Interwar period*, a review was conducted, in addition to literature, included visits to exhibitions featuring work of design studios and designers from the British Interwar period. To achieve Objective 6, *Create a historical archive of colour use in the British Interwar period*, material from several archives was examined to document fabrics and colours to collect a range of colours from various sources. In-person visits were made to three key fashion and textile archives[20] and material was examined in additional digital archives. The archives were selected based on significance of their narrative (engaging with new chemical colours and manufacturing methods), diversity of colour ranges, and accessibility in terms of geographical location. Photographs and sketches acted as documentation and a reflective journal was produced after the visit. A specific colour palette, from spectrophotometry colour measurement, was generated, and used to create a body of design work with CAD, alongside supporting material in sketchbooks, mood boards and a reflective blog.

Next, Objective 7, *Test and apply these colours* was undertaken by first identifying the challenge to print colours from visual analysis which compared the printed designs and colour swatches with the digital screen versions. Finally each method from the modality of visual colour methods was applied and a documented reflective dialogue undertaken to assess their usefulness.

It is essential acknowledge that the researcher took charge of identifying colours for the digital colour palette and selecting the archives, which inherently introduces subjectivity and selectivity. The designs and arrangement of colours were also determined by the researcher, thus reflecting a subjective and selective approach, and in keeping with the creative non-reproducible aspect. The prints were produced in a single print environment and were not replicated. The analysis and annotation of the sample book using the research project's three methods were conducted solely by the researcher as a single instance of their evaluation and would require further external user testing to corroborate the findings.

The work serves a as a practical and tangible example of the complexities and limitations of colour reproduction in DTP. The evaluation demonstrated the complexity of colour matching between the intended colours and their digital and printed representations, highlighting discrepancies when converting colour data and making visual observations, and the challenges of identifying problematic colours when positioned in an overall design. The case study offers a tool for communication to present the modality to the intended audience who are familiar with design techniques - using a brief, colour trends and historical influence to generate colour palettes and pattern designs). Furthermore this activity identifies that the modality would require further refinement, with application on different colour sets, in a range of print environments, and by external user groups to make recommendations for improvement.

2.8.6 Conclusion to Section on Research Activity

Across the lifespan of the inquiry using the method of Praxis, a core body of work has evolved to address the research questions around improving Colour Expectation and Colour Archive testing. The two project aims, and seven objectives were achieved in conducting this work, and the body of colour work formulated into an Exhibition of Praxis work. The activities of the inquiry imply five significant challenges to achieving colour in DTP. And highlighting in particular the substrate's impact on colour outcome. The proposed solution and outcome of a modality of visual colour methods presents a perceptual approach and exploration of methodologies for improving colour expectation in DTP for designers. Furthermore the element of the Colour Archive was used as a test mechanism and application of knowledge, and further demonstrating the complexity of replicating colour in DTP.

2.9 Conclusion: relation to Contextual Review and Experimental Chapters

The three parts of Nelson's model, Know-How, Know-What and Know-That compile a multi-mode epistemological approach coupled with a PaR methodology where constant cyclical input from '*thinking-doing'* (Nelson and Arlander, 2013 p11.) has directed and informed the research activity. Complementary to this has been the understanding of a pluralist realist standpoint where the nature of colour and colour reproduction is seen to encompass both subjective and objective descriptors, and can be influenced by external and internal factors to foster an *anything goes* approach to colour. This contributes to the complexity of the non-reproducible scientific and creative aspects where the inquiry has had to account for the multiple and relational possibilities of colour, within print environments and production conditions which are impossible to control, and acknowledge the variations in the circumstances of the design community using Praxis methods, to consider and address questions around the themes of improving Colour Expectation and Colour Archive testing.

The primary method this study undertook was Praxis, therefore, to reflect the designer's working practices. This method was supported through a range of other methods, as visualised in Figure 12, a multi-faceted approach typical for a practitioner-researcher conducted study, and Nelson's model. Furthermore, this multiplicity has enabled open-ended examination through progressive, demonstrative, and reflective exploration as a tool for communication and acceptance. Two case studies have corroborated research findings; Colour Conversations and British Interwar Case Study which incorporate everyday experiences of DTP, and a real-world application of colour knowledge. The resulting work has been critically analysed through multiple peer review opportunities and expositions, alongside reflexivity, to retain intellectual rigour, scholarly assessment and mitigate bias. This hands-on way of working, coupled with visual outcomes, is beneficial for understanding colour in DTP, because both working with cloth, and the act of design, are naturally nonverbal experiences (Delong et al, 2007). Moreover, colour necessitates visual representation (Parkhurst and Feller, 1982). For example, many colour theorists have devised colour diagrams to explain their work. Therefore, the focus on visual and tactile

semiotics are appropriate to *'articulate the tacit'* (Nelson and Arlander, 2013, p.38) in this research.

The evolution of PaR as a valid and practical research methodology is evidenced by scholars Nelson, Sullivan, Frayling, Leavy, Barrett and Bolt, and Gray and Malins. Significantly, deploying Nelson's approach, where a two-way dialogical process is encouraged for '*mutual illumination'* (Smith, 2009 p129.), provides a structured, flexible and responsive approach for creative research and its assessment within a PhD. Investigations for both the Contextual Review and Experimental research were undertaken simultaneously so that discoveries could inform each respectively as per Nelson's model. For example, the Contextual Review proposed five significant challenges that cause the colour outcome problem to be so difficult which were further substantiated through praxical investigations and industry expert accounts to inform the next steps of exploring and developing a modality of visual colour methods. Thus, the project has used multiple modes of knowing to inform and direct the research activity which have provided capability for incorporating refinements, tangents, and rapid reflexivity appropriate for the exploration of a broad range of fields (textile chemistry, physics, colourimetry, and colour management). Nelson's epistemological model advances schools of thought within the Social Sciences (Wittgenstein, Schon, Collins and Law) which justify his modes of knowing and have been adopted and modified for creative research.

This active exploration of DTP through both praxical experiments and exploring existing material has therefore created a unique body of colour work, presented as an Exhibition of Praxis. The following chapter seeks to understand the problem of colour in DTP and tools for preparedness required to support designers in the measures they must take to feel colour confident (RQ1) and the understanding of scientific theory and production methods that must be utilised by the design community (RQ2).

Chapter Three

Contextual Review

Chapter Three presents the data-gathering and sifting of the Know-That mode of knowing to understand the complex nature of colour and colour reproduction. The inquiry outlines the challenges of printed-colour in the emerging technology of DTP. These include gamut mismatches, numerous variables and adapted technology which provide additional difficulties to the experience of reprographics and photographic digital printing. Outsourced production process and gaps in design education also hinder the designer's ability to resolve colour issues. The review establishes that there is minimal support, and no existing best practice guidance, for designers engaging with DTP, to aid colour matching and consistency from screen-to-print, despite colour being critical in the textile industry.

3.1 Introduction

The chapter is a synopsis of the Know-That mode of knowing - data-gathering and sifting of external content, based on the emerging hypothesis to identify the range of tools necessary for a digital textile print designer, to produce a tool-kit which guides on improving colour in DTP as designers need to overcome a range of problems. This chapter provides an overview of existing and current research in this field, related areas and the problems encountered, incorporating multiple perspectives from accounts of industry experts working in the textile industry.

The chapter introduces the context for the inquiry, which outlines the requirements for a textile designer. As acknowledged in Chapter Two, the problem of colour in DTP within this inquiry sits between science and art with two non-reproducible aspects. The science dimension, impossible to control print environment and production conditions is recapitulated here. Next, the chapter takes three components. First, understanding the colour problem, partly informed through a survey of different digital colour printing systems (Objective 1), and led to the conclusion that there are five significant challenges for

engaging with colour in DTP (Gooby, Becky, 2018b). Secondly, the tools for preparedness, referencing a key body of evidence - interviews with industry experts to identify the strengths and weaknesses of current textile printing practice (Objective 2 and 3). Circumstances within the design community vary and thus the research method used to reflect this, non-uniform, the second non-reproducible aspect, the creative element. Hence, content has been explored to enhance designers' colour knowledge to assist them in navigating the intricacies of the colour issue beyond the scope of specific circumstances. Finally, the chapter presents the underpinning philosophical knowledge which acknowledges the existence of multiple and relational realities of colour, to reconcile the theoretical framework.

3.2 Context of the Inquiry

Achieving a desired colour outcome in DTP presents several challenges for the textile designer. Firstly, there is a gamut mismatch between the additive (mixing colours with light), and subtractive (mixing pigments or dyes) and the colour models used to reproduce colour on screen and in print (Feisner and Reed, 2014). Colour conversion undertaken to translate between the two spaces is complex, remote, and inconsistent (Dawson, 2006a; Henry, 2013) and there are numerous physical variables which can also alter colour outcomes (Provost, 2017) such as print head degeneration, variables in fabric coatings, the weave and structure of the fabric, and secondary processing, as highlighted in a poster presented at Progress in Colour Studies (PICS) 2016 which is shown in Figure 13. Many of these are uncontrollable (Carden, 2015), thus, leading to a lack of standardisation (Ding, 2016). Adapted technology and processes mean that compromises are made particularly in key processes such as CAD software (Henry, 2013), textile chemistry (Provost, 2017) and colour management (Dawson, 2010) which all determine the many variables in the colour outcome.

From a commercial perspective, SMEs and freelancers must drive growth as entrepreneurial progress (Ujiie, 2006). As a work around solution, textile designers are prepared for printing variables and inconsistencies based on their understanding of textile characteristics (Carden, 2015). However, too much inconsistency can lead to significant waste of resources. Therefore, education and the right tools are needed to enable the designer to anticipate issues and problem solve in the initial design stages (Leak, 1998; Henry, 2013; Kelly, 2014), thus reducing colour issues, material wastage, time, and cost.

Based on the above requirements of the digital textile designer, the inquiry asks *What approaches designer must take to feel confident with their colour use in digital printing on cloth?* (RQ1) and *How can the design community understand and utilise scientific colour theory and production methods for digital printing*? (RQ2)

Figure 13 Gooby, B. (2016) Poster presentation from Progress in Colour Studies Conference

3.3 Understanding the Colour Problem

3.3.1 A survey of current design approaches for colour and digital printing on textiles

Digital printing for textiles is a relatively emerging technology despite being in use since the 1970s in carpet printing (Cahill, 2006). The first recognisable digital textile printer was produced in 1991 by Stork. The Stork TruColour TCP2500 was designed for sampling (Kelly, 2014) and superseded by the Fashion Jet Textile printer in 1995 for small print runs known as strike offs (Dawson, 2003; Cahill, 2006). Mimaki brought out their first TX series in 1998. It wasn't until 2003, at trade show ITMA Birmingham, that DTP became an established technology with the exhibition of machines by Du Pont, Mimaki and Reggiani (Moser and Wilson, 2000). Many specialist textile printer companies have since been bought by larger reprographic printing companies establishing DTP as of viable economic interest (Belsham, 2017).

3.3.2 Benefits of DTP and examples of designer engagement

Digital print allows designers to use greater creativity in their print work (Dawson, 2006). Digitally printed textiles can use fine lines and tone, photographic imagery, and digital effects. For example, the work of Marly Van Lipzig[21] and Eugene Van Veldhoven[22]. Colour use is not restricted to the number of print layers. Imagery is not restricted by repeat or screen size (Ujiie, 2006a; Britt, 2012). With low set up costs and the ability to print small batches a designer can be free to customise and be innovative (Tyler, 2005). Downtime is minimal as designs can be printed to demand, responding to changes in trends and markets and wastage is low (Dawson, 2003; Scrimshaw, 2017). DTP can be used as the basis of further textile work such as embellishments (Britt, 2012), for example the work of Alison Bell[23]. DTP can reduce pattern waste by printing direct-to-pattern outlines, although allowances must be made for shrinkage.

DTP has been used in costume design to print the illusion of heavy cloths such as tweed or wool onto light weight, flexible fabrics allowing freedom of movement for the performer[24] or recreate delicate, rare, or expensive fabrics. For example, Figure 14 shows digitally printed replicas of traditional embroidery work by Hatley Print, a print bureau specialising in costume design. Similarly tromp l'oeil effects have been used to print images of jewellery,

sequins or embroidery onto fabrics used in fashion and soft furnishings. For example, the work of Hil Dreissen[25] and Mary Katranzou[26].

Figure 14 Hatley Print (2022): Replicas of original hand embroidered garments from c 1790 including printed coverings for the buttons – used with permission of creator https://hatleyprint.co.uk/case-studies-2/

As with all new technologies the design language is evolving, and time is required to develop it from mirroring techniques and Adobe Photoshop filters (Carden, 2015). The speed at which the technology has developed has hindered designers' abilities to embed and hone their skills meaning that for many the constraints of the technology, and it being an outsourced process, has governed their creativity rather than enhancing it (Carden, 2015). Some design studios, such as Timorous Beasties, whose stand at Decorex International Trade Show is photographed in Figure 15, successfully incorporated DTP into their style using graffiti-like imagery. DTP is seen as an instantaneous option, achieving quick results. However, this leads to frustration for users lacking experience when print-colour outcomes are not as expected and they are unaware that time consuming colour sampling and testing is required (Burton, 2005; Kelly, 2014).

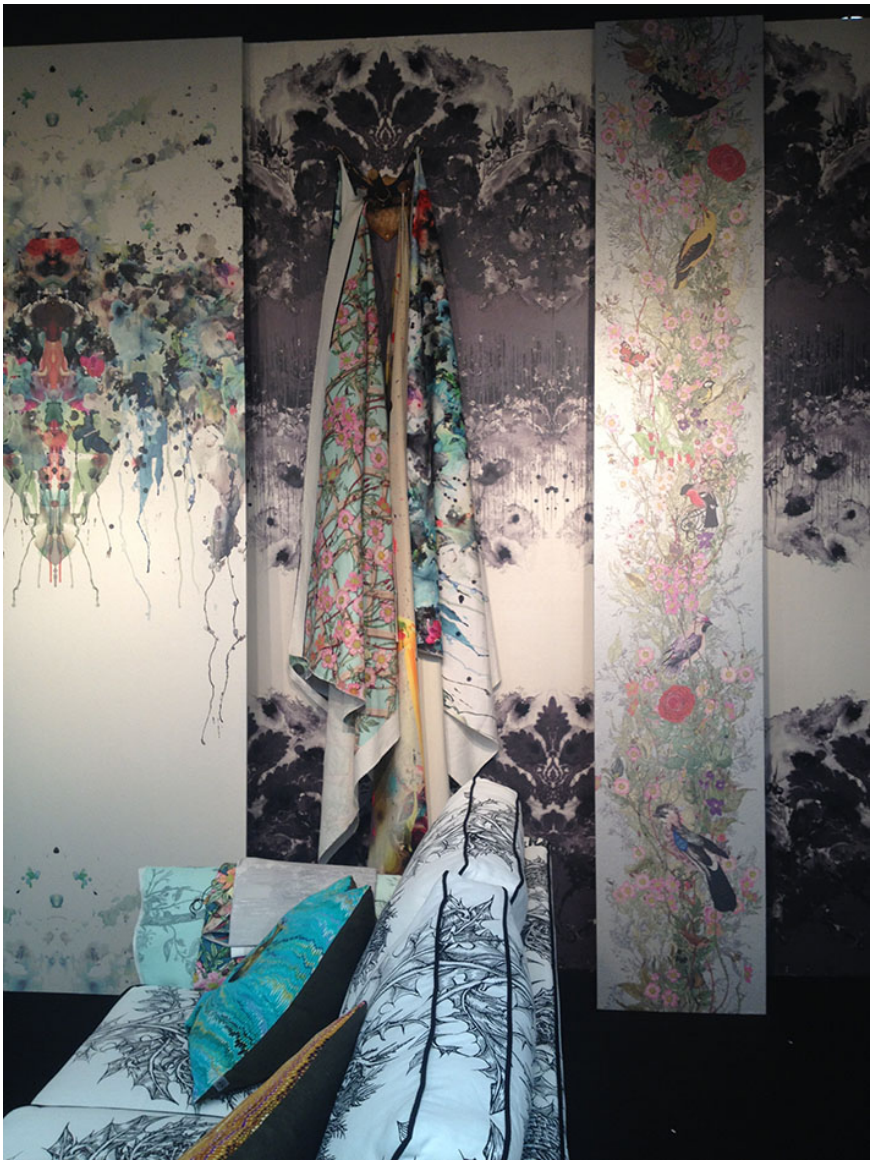


Figure 15 Gooby, B. (2015) Timorous Beasties stand at Decorex 2015

China is the biggest producer of digitally printed textiles with 15% of production in 2016 (Scrimshaw, 2017). Before the technology took off in China, Como in Italy was the leader and retained many specialist companies. DTP accounts for between 3-5.5% of all printed textiles (Hayward, 2017; Scrimshaw, 2017; Ross, 2018). Both Western Europe and Asia are growth markets for production due to urban production and low costs (Hayward, 2017). In the UK government grants have promoted a return to inhouse printing and rapid prototyping enhancing the UK DTP industry (Ross, 2018). Acquisition of specialist companies by larger established firms, for example Epson recently bought Robustelli and EFI bought

Reggiani (Hayward, 2017), may have increased the promotion of pigment and dye sublimation printing over better-quality colour and print options - ink-jet and reactive dyes, due to existing reprographics expertise and practices from the parent companies.

The DTP industry has been driven by Just in Time and Concept to Consumer production and social media trends (Ujiie, 2006a; King, 2006; Polston, Parrillo-Chapman and Moore, 2015). This has attracted entrepreneurial business models (Kelly, 2014). For example, drop shipping where items are commissioned after the order has been placed, reduces the need for stock to be held. Yet the poor adoption of good professional working practices, lack of institutional guidance and a wealth of specialised technology have led to quality and colour issues (Ding, 2016; Ross, 2018)

Several specialist technical applications have been developed utilising DTP. These include using UV or colour changing inks, incorporating nanotechnologies such as antibacterial treatments, printing over electronic components to obscure them (Tyler, 2005; Kelly, 2014) and 3D printing (Hayward, 2016)

3.3.3 Colour reproduction for digital printed textiles

Isaacs and Bowles' publication (2012) '*Digital Textile Design'* can be considered the first prominent *how-to* guide on DTP for designers. The book emerged from *Digital Craft*[27] a project exploring traditional elements through digital techniques. It features experiments by Gearing and Stack (Bowles and Isaac, 2012) with pre-coatings and enables them to digitally print onto coated[28] Victorian Damasks, upcycling old fabrics.

Many studies concern CAD, digital print, and its impact upon creativity (Bunce, 1993; Leak, 1998; Townsend, 2004; Burton, 2005; Polvinen, 2005; Treadaway, 2009; Britt, 2012; Clarke, 2014; Carden, 2015). Polvinen's project explored a collaborative design process, the outcome of which, was the development of colour setting methods utilising saturation, contrast, and brightness levels. Burton describes seeking to *'create the unique aura that traditional tools can'* (Burton, 2005, P.226) through the digital. Likewise, Britt (2012) surveyed designers' approaches to designing using digital tools, encountering the colour

challenges and solutions they implemented. Treadaway documents a collaborative digital process but remarks on the flexibilities offered for colour use (Treadaway, 2006).

Mass customisation and the role of the designer are further questioned by Neuberg and Bowles in The People's Print[29]. Bowles's research includes *Smorgasbord*[30], an educational device to play with pattern and colours, then interpreted into digital print. Bowles is a member of Textiles Environment Design [31] (now Centre for Circular Design) and Neuberg, similarly, interested in sustainability forming the Slow Textiles Group[32]. DTP is environmentally friendly with a reduction in ink-wastage and water, smaller carbon footprint and print-to-demand capabilities.

Digital Print Bureaus (DPBs) offer a DTP production service to designers and SMEs. They are primarily located in urban environments speeding up textile production to retailer (Ujiie, 2006). There are international, commercial DPBs such as Spoonflower and Contrado and smaller independent businesses. A survey of DPBs in the UK revealed several established companies (e.g., CAT Digital, Silk Bureau, FabPrint). However, operating a DPB is also challenging with many companies closing (e.g., Cameron Gilmartin BeFab, Surface Pattern Print). Some have specialised in a particular field to retain viability (Silk Bureau, Hartleys).

The designer will not commonly oversee any of the production process and prints are made in their absence (Carden, 2015). Commissions may even be conducted entirely online with fabric delivered, negating any need for contact. Designers need to learn how to communicate with a DPB and practical support from the DPB on how to prepare the artwork, which colour management processes they use and information about their print environment (McKeegan, 2017, 2018a) to ensure a satisfactory outcome and avoid re-printing.

To attain *'methodological rigour'* (Nelson and Arlander, 2013 p58.) Nelson's ascribes to examining the approaches of practitioners working in similar territory to establish what is already known and to extend the researcher's scope beyond textual and traditional knowledge. Therefore a survey of designers working with DTP was undertaken and features

in the project's blog[33] in order to gain insight into other's practice. Designers of note include Basso and Brooke, Susi Bellamy, and Timorous Beasties[34].

Be Fab Creative, a DPB, who participated in the Colour Conversations described how they felt incredibly naïve entering the industry. They felt frustrated by the lack of shared information amongst DPBs which they felt were down to commercial sensitivy. Initially they had been advised to alter artwork to try to match the colours their customers expected but found that this caused problems when repeat batches were ordered. They upgraded their colour management processes to improve colour consistency and found that with increased experience they could achieve better colour accuracy. (Appendix F , p4)

Research by industry at InkDrop Boutique[35] discovered that mass customisation was challenging to manage because of colour issues and image quality. They attempted to solve these through '*managing expectations'* (Maguire King, 2006 p333.), offering guidelines and minimising variables. Other print bureaus have attempted similar. Lacuna Press[36] , a DPB, provide its own design library that you may download and customise alongside colour management tutorials[37].

Ujiie's (2006) *Digital Textile Printing* is aimed at industry offering a research overview bringing together studies on textile chemistry, colour management and print technology. Published in 2006 it is still the most comprehensive academic publication on DTP. However, most of the current research remains in journals and conference proceedings (Ujiie, 2006). Ujiie (2006) promotes the idea of the designer as an entrepreneur describing it as revolutionary and, like Kelly, recognises the importance of education. He prescribes a cross-disciplinary approach to broaden the end use and definition of textile design.

Carden's *Digital Textile Printing* (2015) brings a historical context, drawing connections between spray techniques of cave painting and graffiti with ink-jet printing, alongside a deeper consideration of the technology as a craft tool, and the different components that make up DTP. She reflects upon the relationship of the designer and practitioner with DTP, highlighting the lack of hands-on experience and questioning authenticity within the print process. The emphasis on connecting with spray painting and craft can feel in opposition

with modern digital technology and colour management algorithms. Tyler's *Textile Digital Printing Technologies* (2005), similar to Ujiie, assesses the different factors of the digital textile print environment, surveying the options available. His guide is comprehensive and practical but lacks the designer's voice.

Early pioneers of DTP have included Malcolm Cocks[38] and Joan Truckenbrod[39], who have exploited techniques and computer coding to produce innovative digital pieces. Boeme[40], BlackPop[41] and Timorous Beasties[42] are all successful brands exploiting digital print potentials. Clarke (2014) highlights further designers harnessing digital print in *Fashion, Interiors and Art*.

3.4 Production challenges

3.4.1 The criticality of colour in textiles

Colour is a significant feature in retail (ASBCI, 2014a). Studies have shown that the eye is drawn first and foremost to colour before print or texture (Briggs, 2013) and is an essential factor in purchase decisions (Briggs, 2013). We choose the colours in our homes and our wardrobe because we like them (Rigg, 2006). Products may be sold year in year out with a simple colour change to update them. Colour attracts attention and will entice the consumer. (Udale, 2014; Rigg, 2006). Therefore, colour is very important to the fashion and textile industry (Shen and Xin, 2006). A textile designer must be colour confident (Clarke, 2011 p143.) to achieve a successful product (Maguire King, 2006; Briggs, 2013). The human eye is a very good assessor of colour. If a colour does not appear to be correct no amount of spectral data can convince the eye otherwise (Rigg, 2006).

3.4.2 Colour categorisation – challenges in quantifying and defining colour

For the designer it is important to recognise the three colour systems, additive, subtractive and partitive. The additive system describes how the computer screen can reproduce colour. The subtractive system describes how we perceive a digitally printed textile as full colour. The partitive system describes how our visual perception can be influenced, altering colour perception (Feisner and Reed, 2014).

Additive or RGB (red, green, blue) as traditionally viewed on monitors and cameras and Subtractive or CMYK (cyan, magenta, yellow, black) as used for printing have since been adapted for digital technologies(Westland and Cheung, 2012b, 2012a). Figure 16 shows a comparison of two generic colour spaces derived from RGB and CMYK to visualise how they overlap, yet retain the ability to reproduce colours that are unique to each other. Using existing processes and adapting them for digital has aided transition, whilst incorporating idiosyncrasies which may have been avoided if the technology had developed differently. The RGB model which uses spectral sources and is easier to program with, has become prevalent in CAD software (Schwarz, Cowan and Beatty, 1987; Fraser, 2004; Henry, 2013).

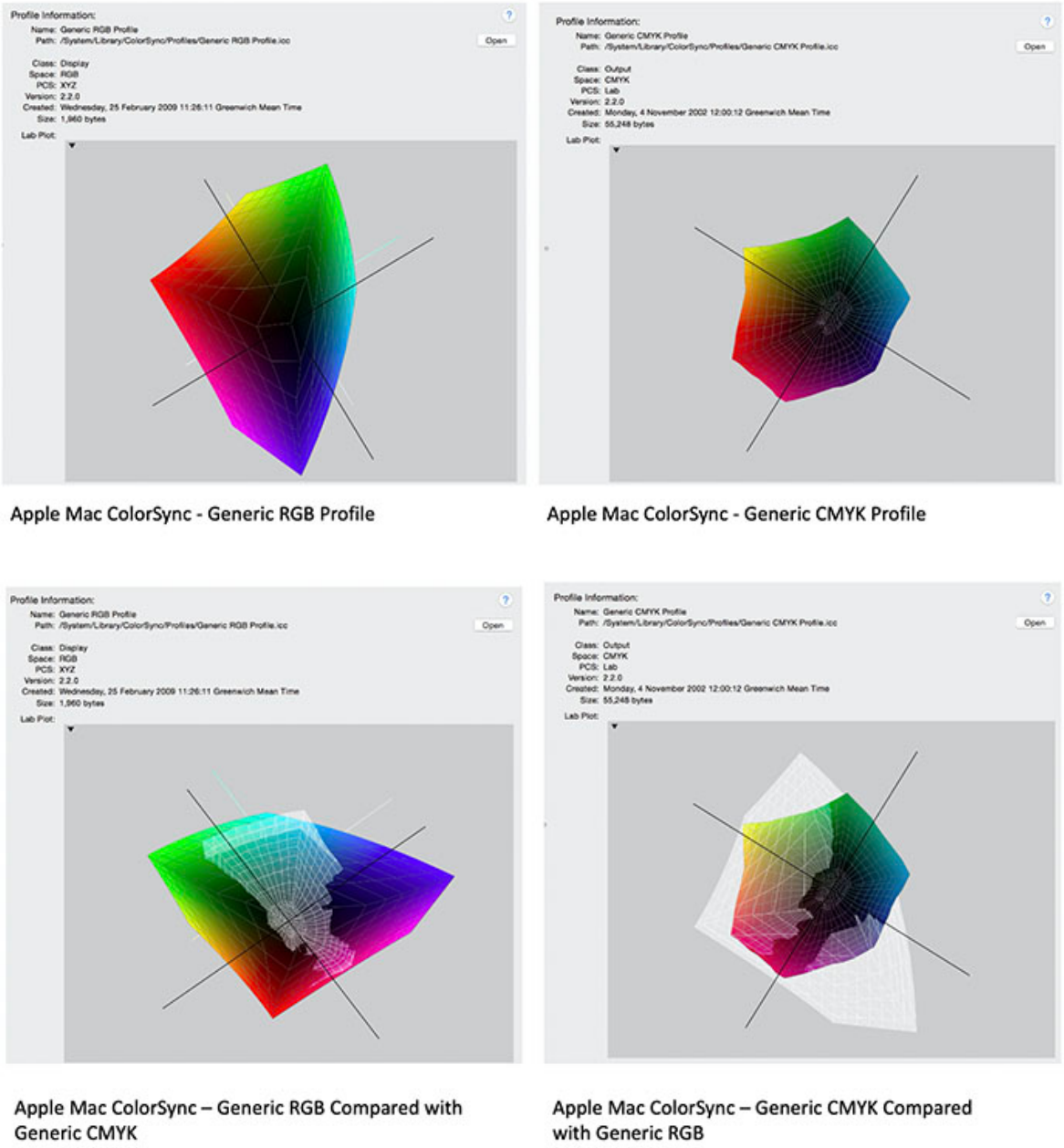


Figure 16 Gooby, B. (2017) Apple Mac ColorSync comparisons of generic RGB, left, and generic CMYK, right, gamut. The bottom row shows the gamuts superimposed onto each other

3.4.3 Commercial Colour Systems - Pantone©

The Pantone© Matching System offers a colour library of over 1,000 colours. It can be used to communicate colour specifications when commissioning design work and is widely used in the industry including fashion and interiors (Udale, 2014), as well as widely in the

reprographics industry. It is consequently recognisable by designers who are engaging with digital print (Tyler, 2005). Figure 17 illustrates Pantone© Solid Uncoated Library artwork which was created for the Colour Reference Book p.165. Figure 18 shows Design Studio, Studio Flock, using various swatch charts, including Pantone© references for cross colour matching a printed design.

To make a colour comparison, using a range of tools, such as a spectrophotometer, colour matching is straightforward to use but requires that the user should have the same edition, kept under the same conditions as the person they are working with, to specify an identical colour (Green, 1995; Hirschler, 2014). Many have now expanded to offer examples of colour harmony and forecast trends (Clarke, 2011). The system is based on the combination of CMYK percentages. However around 20-50% of colours cannot be accurately matched using CMYK ink-jet printing due to the printing method (Tyler, 2005; Setchell, 2012) Pantone© textile swatches are dyed, rather than printed (Clarke, 2011). Other commercial colour model spaces include the Natural Colour System, British Colour Standards, and the Munsell Colour System.

Figure 17 Gooby, B. (2016) Artwork of the Pantone© library used for the swatches for Colour Reference Book. Created by repeatedly filling a 10x10cm JPEG image file with each hue from the library and compiling these into one large contact sheet in APCC, with colour reference text label

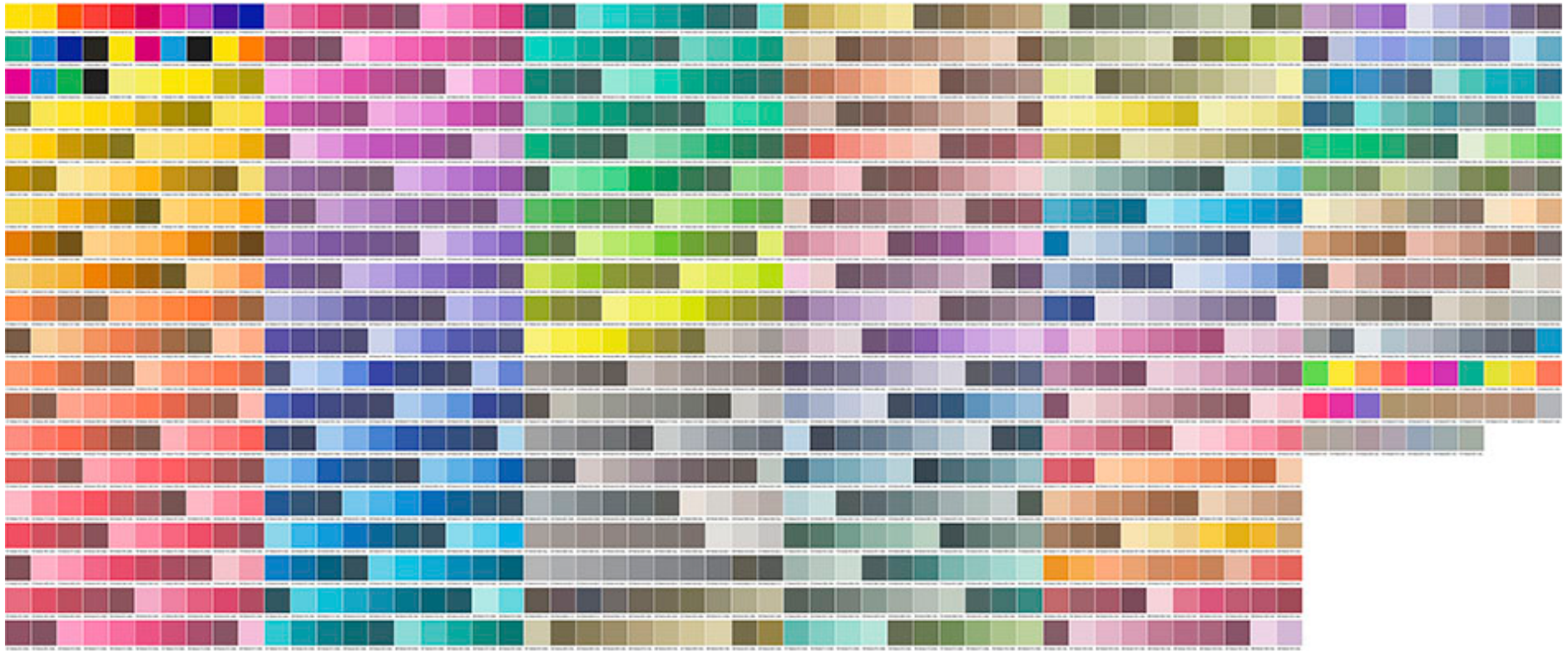


Figure 18 Wingfield, J. (2017) Super Colourful Studio - used with permission of the creator

Studio Flock using Pantone© Chips to colour match

3.4.4 Natural Colour System[43]

The Natural Colour System (NCS) is communication colour model that organises colours based on perceptual dimensions such as hue, chromaticity, and lightness (Feisner and Reed 2014) defined in percentages to form an NCS notation. It is used within fields of design, architecture, and paint colours.

3.4.5 British Colour Standards[44]

British Colour Standards was a framework of co-ordinated colour ranges grouped according to industry to aid colour communication and specification across the British Empire in the 1930s (Feisner and Reed, 2014, Baty, 2020). It is now primarily used for paint colours to evoke a sense of nostalgia for colour trends from the 1940s and 50s.

3.4.6 Munsell Colour System[45]

The Munsell Colour System is a three-dimensional form with intervals of lightness, darkness, and saturation (Feisner and Reed, 2014) using the partitive system, and concept of after-

image. It was developed by Albert Munsell (1858-1918) using five principal colours and their complementaries and used for colour communication across various fields including art, design, and science.

3.5 Gamut mapping

The conversion between the screen's RGB colour space to the print's CMYK colour space is a challenge, and Leak (1998) and Dawson (Dawson, 2006a) explain gamut mapping. Leak outlines the MacDonald method[46] and Dawson recommends mapping concerning the print purpose[47]. He notes, in 2006, that no research exists into mapping on textile substrates. Javorsek and Javorsek (2011) test out specialist colour management systems, considering proofing methods for DTP. They conclude that paper print proofs are the best way for designers to gauge colour outcome but do not detail which papers or profiles. Loser and Tobler (2010) argue that the number of variables involved in the print environment, makes it difficult for profiles and software to map colours, supporting the designer's role in mediating colour expectations. If a design uses colours outside the achievable gamut of the intended CMYK print environment it is impossible to achieve colour accuracy (Tyler, 2005). Linear algorithms are complex in CMYK colour spaces and so conversion is usually undertaken via CIE LAB. *Commission International de'Eclairage* (CIE) colour spaces use colourimetric, or measurable, specifications to mathematically map of human vision under a defined set of observation standards. CIE LAB (1976) is widely used in many applications to aid conversion from RBG to CMYK colour spaces because it has more considerable colour capabilities and is compatible with colour-measuring devices. Yet CIE systems are based on measurements using spectral purity impossible in reality (Osborne, 2017). Inaccurate colour conversions between RGB and CMYK colour spaces will result in poor contrast, dull, muddied, or bleached colours, inferior colour balance and colour deviation (Green, 1995).

This is reinforced by the work of Ding (2016) whose doctoral studies examine colour management for producing digitally printed textiles in industry. She concludes that a lack of standardisation and adaption of colour management technology, without consideration for textile characteristics, leads to problems in printed-colour outcome. She developed a set of principles for the future development of colour management technology for DTP.

Ensuring that accurately converting grey scales can improve colour conversion and prevent banding (Green, 1995), several techniques have been developed to aid the overall print-colour outcome including Under Colour Addition (UCA) which adds colour to the deep

shadows to improve colour balance after conversion (Green, 2010). These techniques have been developed for reprographic and photographic printing, but the inquiry's review was unable to find research which tested them on textile substrates.

3.6 Problems with subjectivity concerning visual assessment and how this connects with the value and utility of a tool-kit

While there exist multiple criteria and tools for evaluating colour, such as spectrophotometers, it is essential for these instruments to adhere to industry standards, as outlined in the Instrumental Colour Measurement of Textiles Standard (BS8475:2006) (SDC, 2008) or Visual Colour Management (SDC Standard 1/01 2008) [48]. However, it is important to note that these standards currently do not provide specific guidelines for measuring digitally printed fabrics.

Much is still undertaken as a subjective activity and visual assessment requires matching and comparing across different materials, for example, substrates that may be highly textured. The nature of colour is multifaceted, encompassing various factors such as the interaction between light and objects, the spectral power distribution of reflected light across different wavelengths, the processing of visual information in our brain, and the subjective experiences of colour as a psychological phenomenon. To maintain colour constancy the brain may discard information about colour changes from altered lighting conditions for example to retain the perception of a banana's yellowness, different to the phenomena of metamerism (Parraman and Segovia, 2018).

Further visual information is derived from texture, a visual attribute that allows us to differentiate between different materials, discern the structure and shape of objects, and identify edges within a complex visual scene (Kentsis, 2005; Jongerius, Manse and Rawsthorn, 2016; Mikellides, 2017; Parraman and Segovia, 2018)

Designers need to consider how their product will work as a functional object, whether it be a textile, furniture or architectural piece (Udale, 2014). Therefore, understanding the transformative, subjective nature of colour is vital in an industry where colour fidelity is crucial (Clarke, 2011). In addition comprehending different colour systems including those that impact digital colour, designers' colour palettes may be developed from a range of inspiration including trends, charts, swatches, yarns, threads, magazines, and competitors' collections (Little Wood, 2006).

A design brief, as illustrated in Figure 19, may include a theme, visual examples including design styles (floral, geometric, conversational), product application, client expectations, target market as well as a colour palette or range of colours (Briggs, 2013). This wide range of stimulus makes colour chain communication and colour fidelity difficult.

Figure 19 Gooby, B (2017) Example of design brief

There may be an extensive colour supply chain which can include a textile mill, colouration laboratory, dye factory, cutting and sewing production, and the retailer. Many of these may also be overseas (Lawn, 2006). Secondary components such as buttons, linings, thread and zips, and the grouping of sewn pieces after pattern cutting, will also require colour matching and must overcome strict colour tolerances (Lawn, 2006) which are difficult to achieve (Harnie, 2017). DTP can overcome some of these issues as production can be undertaken at a smaller scale at a geographically accessible location, negating the need for colouration labs and dye factories.

Therefore, as humans see colours differently there is an issue of subjectivity in visual assessment. Johann Wolfgang von Goethe (1749-1832) was the first to study the eye's

interpretation of colour, focusing on perceptual aspects rather than light properties. His work explored complementary colours, shadow creation, contrast effects, lighting influence, and proportional colour use (Goethe and Eastlake, 1840; Matthaei *et al.*, 1971; Kentsis, 2005). Michel Eugène Chevreul (1786-1889) furthered Goethe's theories on colour harmony (Westland *et al.*, 2012) and contrast by studying the reactions of colours when juxtaposed (Chevreul, 1839). His work expanded Goethe's insights, exploring the interplay between colours and their effects on perception. Both define colour as being a (subjective) perception of the mind that causes complications when trying to align such concepts with (objective) spectral thinking where colour is described through data and as a physical property of an object (Cohen, 2004).

Consequently, as Goethe and Chevreul have demonstrated, human colour perception is highly subjective, and so visual assessment might be perceived as a potential limitation particularly without access to colour measuring tools and controllable lighting conditions. However, the value and utility of providing a tool-kit for designers engaging with DTP are, therefore, to give a foundation of insights and practices related to colour in DTP, such as resources like Table 6 which seek to make recommendations of general techniques that designers can deploy and enhance colour expertise to fine tune the tool of the *designer's eye*. The aim is to empower designers to navigate the complexities of colour more effectively and make informed decisions while improving their colour proficiency.

3.7 Colour consistency and problems encountered in ink-jet printing

Ink-jet printing has become an increasingly popular method of textile printing (Hawkyard, 2006; Dawson, 2006a) as it provides designers with a more significant number of colours in comparison to more traditional methods but requires a different range of colour controls and frequently re-printing happens in order to obtain colour accuracy (Carden, 2015). Initially used for strike-off and sampling production because of production capabilities, which have since improved.

Colour consistency remains an issue as each new print will differ because of the unpredictability of colourant batches and base cloth fibres (Carden, 2015). In addition, the print speed, type of printer head and print alignment may also impact colour outcomes (Hitoshi Ujiie, 2006b). The requirement of colour consistency across fibres, substrates, and components (Udale, 2014) and overseas production with different time zones and lighting conditions (Best, 2012) requires accurate colour communication. Colour descriptions can be vague and biased so other forms of colour communication must be used (Leak, 1998). This has developed into a vital enterprise in the textile industry with companies such as Pantone© and Natific selling colour communication services. Textile designers therefore need to be competent in colour specification and approval (Best, 2012).

The DTP industry currently favours dye sublimation printing and ink-jet printing with pigment inks due to lower maintenance and costs. However, both have an increased likelihood of metamerism which has not been addressed. Metamerism is a particularly unwelcome phenomenon in the printing industry as it can be a costly mistake for dyers and printers. Metamerism is where an object may be perceived as the same colour as another under one set of conditions yet differs when these conditions are altered (Carden, 2015). This causes problems in the textile industry where products are sold, and photographed, under bright lighting conditions which differs from daylight or lighting in domestic interiors and must match or harmonise with other products. Products that appear altered when viewed out of the store or at home lead to customer dissatisfaction (Gegenfurtner et al, 2015) .

In DTP with dyes, the colourant requires post treatments for fixation and end use. Dots are emitted on demand, or continuously, which uses more ink and is therefore expensive (Parraman, 2017). The smaller the dots, the paler the colour (Feisner and Reed, 2014). Dot gain describes the issue of dots altering in shape or size when they hit the surface of the substrate which impacts the colour perception (Fraser, 2004). This is a challenge in textiles substrates as they have textured rather than smooth surfaces so the dots spread differently to paper (Dawson, 2006b). Textile substrates are usually pre-coated, mimicking the glossy surfaces applied to printing paper which can reduce dot gain (Tyler, 2005). Colour management processes which work with pixels rather than dots do not rectify this issue (Ding, 2016).

The jetting method and the print head determine the printer characteristics. Print heads suffer from clogging and misfiring and so machine maintenance and ensuring that an optimum print environment is in place affect colour outcome. Colourants must have an incredibly pure and specific viscosity, less than 5mPas, and tolerate 10mPas. (Tyler, 2005). Other variables are the make of the machine[49], whether the machine uses continuous or drop-on-demand print technology, the drop formation (Carr *et al.*, 2006) and the speed, positioning, make-up of and type of print head (Mariano Freire, 2006). Bubble-Jet and drop-on-demand printing are favoured because of suitability as the alternative method, thermal jet, is a fire risk, and cost as drop-on-demand uses less ink than continuous tone (Dawson, 2006b)

Industry seeks to increase production by achieving faster print speeds (Raymond, 2006), but this is a challenge with textiles which must balance surface tension, print alignment on a textured surface, the feeding of the fabric through the machine, alongside colour yield and dye penetration (Caccia and Nespeca, 2006). Advances in colourants, print heads (Weidt, 2017a, 2017b, 2017c, 2017d) and coatings (Steele, 2016) are attributed to improving colour outcomes in the past years.

3.8 Colourants

Colourants can be classified as dyes, organic compound molecules dissolved in water or an organic solvent, or inks (pigments) - non-organic particles in a suspension (Hoskins, 2004; Carden, 2015). The purity of colourants is determined by cost, stability (ABSCI, 2014) and multiple end-use requisites meaning quality may be compromised (Fraser, 2004) impacting colour outcome.

Dyes have a superior colour range whilst pigments produce more permanent colour and do not require additional processing (Carden, 2015), for example, steaming and washing for fixation. Dyes are soluble and more suitable for ink-jet printing because they have a low viscosity and can pass through the print head (Miles, 2010). Pigments can be ground small enough for ink-jet printing but frequently clog print heads with small particles (Carden, 2015). Dyes and pigments have limited shelf life. Colour stability is, therefore, not guaranteed. A colourant's viscosity and consistency are key in managing colour outcome (Ingamells, 1993).

Similarly, the fibres used to make substrates are also variable (Carden, 2015). Colourant developers must consider how a colourant will react with different fibres, and the pre and post-treatments they undergo (Tyler, 2005). The colour outcome will also be affected by the amount of moisture in a colourant or substrate (ASBCI, 2014a). Colouration is a complex and variable process and the method of transferring the colourant and binding it to the fibre is not exact (Ingamells, 1993). An image reprinted under the same conditions can therefore still appear different because the chemistry is imprecise (Carden, 2015).

3.9 Substrates, pre-coatings, and steaming

The construction, yarn and weave of a fabric all affect the achievable colour gamut (Carden, 2015). The end-product will ultimately define the fabric choice (McKeegan, 2018b). Cotton, polyester, and hybrid fabrics are the most common fabrics in DTP, but silk, wool and linen are all compatible. Each has its absorbency, surface tension and potential for wicking, where the fabric is over-saturated, which impacts the optimum amount of colourant that can be used (Ingamells, 1993; Campbell, 2006; Carden, 2015). Colour management processes do not yet incorporate data about these variables in their settings which would be recommended (Ding, 2016).

Fabric construction is complex and there are several processes to prepare for print (Provost, 2011), for example, singeing, scouring, and bleaching (ASBCI, 2014b). Fabrics are primarily three-dimensional constructions, woven or knitted (Kim, 2006) and therefore, the space between the fibres requires consideration too, as this will impact colour perception (Miles, 2010). Protein fibres, made by animals, have good absorbency and colourant retention as does cotton and bamboo, cellulose fibres. Other cellulose fibres, such as linen and hemp, which are oilier, have less absorbency and prints tend to fade. Synthetic fibres, which are derived from petrochemicals, have poor to little absorbency and so colourant sits on the surface, reducing rub-fastness (Ingamells, 1993).

Digitally printed fabrics require additional pre-treatments (Hawkyard, 2006) to prepare them for printing. Pre-coatings are adapted from knowledge of the binders and thickeners used in traditional dye and print pastes (Hawkyard, 2006). They also help reduce drop gain, where an undesirable colourant spread occurs when it hits the textured surface. Pre-coatings are also included to enhance print-colour quality and provide properties for textile end uses. Once printed, the substrate is steamed and washed to allow the binders and thickeners to react with the colourants, enhancing the achievable colour gamut and quality (Provost, 2013). Coatings use conventional textile chemistry, for example acid and alkaline treatments (Dawson, 2006b), to aid fixation, print and colour quality and end use (Provost, 2011). They have high viscosity levels, so they cannot be jetted using typical print heads and there are concerns about damage to the machinery if they were (Provost, 2011). A bespoke

coating for the print environment - fibre and colourant combination, would give the best outcome but many fabrics are supplied with a generic pre-coating (Tyler, 2005). Coatings must be consistent and stable (Provost, 2013) to achieve the chemical reactions necessary for colour yield penetration (Miles, 2010). Therefore, the textile chemistry required for colouration is compromised by adapting print heads from paper printing, and consequently modified into a two-stage process by separating the pad liquor from the print paste, increasing the chance of colour variation.

Likewise, the steaming process must be uniform to achieve desired chemical reactions (Carden, 2015). Kelly (2014) notes that adjusting steaming times improves colour outcome and advises lightening colours in design software to counter any darkening effect caused by steaming.

3.10 Creative practitioners response to colour constancy and colour phenomena challenges

Dr Adrian Leak (1998), whose doctoral studies was the first to research DTP from a designer's viewpoint, experimented with contrast effects and created prints influenced by dither patterns. He comments that the resulting works demonstrate *'the difficulty of applying theory to practice'* (Leak, 1998, P.169) and the limit of the printer's gamut. Leak, influenced by Bridget Riley and Peter Phillips, created fugitive colours, and experimented with the Bezold effect[50]. A similar experiment was conducted for the research project, prior to encountering Leak where colour wheels were generated using CAD and adjusted using colour balance tools.

Hella Jongerius' exhibition *Breathing Colour* (2017) is a significant demonstration of a designer's capacity to study colour (Jongerius, Manse and Rawsthorn, 2016). The exhibition features several installations to visualise changes of perception influenced by the environment - changes in light, orientation, volume which are shown in Figure 21. An example of her colour process is depicted in Figure 22 where cut outs from paintings of a set of glazed pots are placed alongside to create colour palettes. A film piece, depicts Jongerius meticulously matching samples to Abraham Werner's *Nomenclature of Colours,* all of which provides an insight into a designer's ability to match colour (Jongerius, 2017).

Garth Lewis (2013) developed a body of research in collaboration with Dr Ferdy Carabott, a photographer and computer imager, to produce *Chromafile*, a colour tool that mimics subtractive mixing digitally, producing *a 'paint colour space[51]'* (Lewis, 2013) to aid intuitive subtractive colour mixing interface for designers. As illustrated in Figure 20, the software is currently standalone and would need to become a plug-in for design software to improve functionality.

Figure 20 Lewis, G. (2013) Image from Virtual Colour Course comparing physical subtractive mixing of paint and the digital version – used with permission of the creator

Similarly, Dr Phil Henry's Colourmimix, (2013) offers designers a digital subtractive colour mixing tool. Developed for APCC as a plug in, it arose from Henry's doctoral studies into issues with colour picker tools in computer design software. Sadly, due to intellectual property constraints the plug in is no longer available and was not able to be tested as part of this project.

Figure 21 Gooby, B. (2017) Helle Jongerius Breathing Colour Exhibition at Design Museum

Both Lewis and Henry's endeavours highlight a defect in education in relation to gamut mismatches. Colour education primarily focuses on subtractive colour mixing and symbiology (Mikellides, 2017; Osborne, 2017). Knowledge is built from experience and tacit use (Elkins, 2014; Emlyn Jones, 2014). Yet, as explained in the following section, many colour education models in design focus on subtractive mixing – pre-computers, pre-digital, to the detriment of digital colour mixing (Henry, 2013).

Figure 22 Gooby, B. (2017) Helle Jongerius Breathing Colour Exhibition at Design Museum

3.11 Colour education

Inaccessibility is a particular issue for digital colour creation which is mainly automated and difficult to infiltrate. Users feel naïve and experience a lack of control when engaging with digital colour and digital print (Parraman et al, 2013). Kelly (2014) pinpoints the teaching of colour in Higher Education as key to improving digital colour issues. Kelly asserts that lack of comprehension of number of variables, and of additive mixing, is a hindrance for designers and prescribes a model for teaching digital colour in textiles. Furthermore, she argues that digital colour education is inconsistent across undergraduate design curriculums and an understanding of DTP is lacking in the wider design community (Burton, 2005; Kelly, 2014).

Students of textile design will be taught, and gain experience of, colour harmony and colour relationships, in particular understanding theories of contrast where colour positioning and scale will have an impact on perception. (Clarke 2011; Udale, 2014; Briggs, 2013). Many students will also gain knowledge of textile chemistry, for example dyeing and creating effects through discharge pastes, heat, or binding. They will learn about different substrates and observe how cloth reacts to colourants and treatments. This gives them some understanding of the variables that impact colour outcome in DTP. For example, they will be prepared that printing on linen will look different to cotton (Briggs, 2013). However, this education lacks the skill and knowledge of colour mixing in computer software (Henry, 2013), and the principles of colour management, calibration, and colour technology (Kelly, 2014).

Whilst many students will be taught the importance of colour sampling and how to use colour reference systems to specify colour (Kelly 2014; Clarke, 2011), a lack of knowledge of the bigger picture of colour fidelity in DTP leaves them without the ability to question colour outcomes, solve colour issues and work with a DPB (Maguire King, 2006).

For designers from other disciplines the gap in understanding may be different, particularly in relation to inconsistencies with textile characteristics. The designers behind BlackPop come from a photographic printing background so had a good understanding of colour management which they used to manage their colour outcomes. Other designers, such as

Designer Consultant A, talk about playing with CAD software using trial and error to find a method that worked for them. Studio Flock, from a graphics background had worked hard to develop a relationship with their print bureau to aid their grasp of colour management.

Both Henry (2013) and Lewis (2013) call for design software to be more representative of existing colour education and use subtractive mixing models (Albers, 1972; Itten, 1975) . Henry states that designers often ignore colour management because it is abstract and remote which would change if subtractive mixing was utilised.

Designers already have expert colour knowledge. For example, creative practitioners have been shown to have better colour memory (Eiseman, 1990) and to be able to make complex and accurate colour decisions using instinctive sense of colour (Henry, 2013). This comes from continuously working with and understanding colour (Kiely, 2010). Yet if education is lacking around digital colour, it is easy to understand why many become confused about colour outcome (Burton, 2005).

With DTP the designer is absent from the printing process (Carden, 2015). The colourants and cloth are not made by the designer. The printing is undertaken remote from the designer. This loss of control (Parraman et al, 2013) impedes their knowledge to problem solve. Additionally, there is a gap between what a designer is led to believe is possible, and what is achievable (Henry, 2013). This design mirage is created through a number of means.

Firstly, software allows users to select unprintable colours, viewed on a luminous screen. Replication of traditional mark marking and the expedition of hand techniques in computer software supports a belief that CAD offers miraculous possibilities. This perception can mask the restrictions and limitations of the conversion from screen to print, which coupled with an outsourced, and therefore removed, print process, may lead to disappointment and frustration with the printed outcome (Burton, 2005).

Secondly the communications between DPBs and designer is problematic partly motivated by the need for secrecy in a commercial set-up but also due to financial barriers and vocabulary misconceptions (McKeegan, 2017). There is a lack of explanation from DPBs

around resolving colour differences and the key variables in the process that will affect colour outcome. This is further complicated as designers are unable to ask the right questions of their DPB because they are unsure what questions to ask (McKeegan, 2017).

Traditionally gaining industry experience has improved designers' comprehension of production processes (Burton, 2005), however the opportunities to gain industry experience have decreased with changes to the way design work is commissioned[52]. The entrepreneurial potentials of DTP have led to more designers setting up their own businesses (Ujiie, 2006), but without the support of such experience. In addition, DTP has permitted designers from other disciplines - interior, illustration, graphic-design, and photography, to design for printed textiles, without textile Know-How leaving them unprepared to solve colour issues (Carden, 2015). There is minimal support, and no existing best practice guidance, for designers engaging with DTP, to aid colour matching and consistency from screen to print (ASBCI, 2014a).

In summary to understand the colour problem, multiple perspectives are required. Designers engaging with DTP must take measures around numerous variables and account for the gamut mismatch between screen and printed-colour (RQ1). The outsourcing of this process, adaptions from paper printing and traditional colouration processes, further hinder their ability to resolve colour issues. This is compounded by inconsistent colour education on digital colour and lack of industry standardisation and best practice around production processes leading to frustration and increased costs due to reprinting (RQ2). Whilst there have been attempts to create solutions, the subjectivity of colour and the multiple influences on printed-colour outcome have led this inquiry to conclude that visual colour methods that indicate how a colour might be impacted on screen would be of value to support colour confidence and allow designers to take measures in the design stages to resolve colour matching issues (RQ1). Furthermore providing foundational information and pedagogical guidance in the form of an accessible online tool-kit will enable designers to make informed choices about colour in DTP (RQ2).

3.12 Tools for preparedness

Multiple perspectives have been incorporated to corroborate the positionality of the researcher in the form of accounts from industry experts, and a review of strategies to improve colour outcome in DTP.

3.12.1 Colour Conversations that have led to development of a modality to aid designers colour expectation

To understand what were the challenges for designers and in the digital print industry as part of the contextual review, a series of conversations with a range of industry designers were undertaken, which were presented as case studies at The Textiles Institute Conference in 2017 and listed in Appendix F. Participants cited textile chemistry and colour management as challenging, one designer described how they avoided using difficult to reproduce colours, especially deep shades *"I've stopped using black and went for a really deep sort of maroon, burgundy shade… I think I've tried to avoid it since, or I've warned a client, there's a lot of black in there. You need to be aware that might be problematic"(*Appendix F p42.), another designer indicated the lack of communication with the printing bureau *"At no point did the printers give me any guidance on obtaining the colours I wanted, I was not for instance provided with a colour profile or a recommended colour space to use." (*Appendix F p83.); another said that they had developed work around solutions, which were initially costly (Appendix F p15.).

Be Fab, Digital Print Bureau said colour in DTP was "*a brick wall I have banged my head against for the past three years"* (Appendix F p5.) talking about how commercial sensitivity within the industry had led to a lack of knowledge exchange and sharing of best practices, which promoted poor working practices. For example, they were advised that a typical method for colour matching in the industry was to adjust the colours randomly in the design so that they would print as the customer expected, but that this caused problems with print consistency when the customer returned to print a repeat batch.

Costs of frequent reprinting to get colour accuracy and additional labour costs for editing CAD files was also too often hidden from customers. Be Fab felt that many customers didn't

understand the DTP process and that their expectations on printed-colour outcome were based on what they say on their back lit screen saying, *"very few people use a matt screen…very few people have them colour calibrated…they'd be saying well it's not the same as what I see on screen"* (Appendix F p11.). They raised problems such as "*there's a whole load of variables that you can't control or science out"* (Appendix F p7.). Design Studios, Black Pop, Earthed Fabrics and Studio Flock all cited good digital colour knowledge gained from commercial experience, and a good relationship with their DPB as key to achieving colour expectation in addition to restricting the number of textile substrates. Earthed Fabrics said, *"most of the colour issues are likely to come from either the raw materials, your base cloth, or your processing"* (Appendix Fp26.) going on to emphasise that *"the chemistry is so important"(*Appendix F p27.) which as traditional colouration processes have been compromised to adapt to DTP has brought additional challenges.

Designers' innate sense of colour and '*colour magic'* (Appendix F p45.) were also cited as useful tools by Designer Consultant A and Studio Flock, supporting Academic Phil Henry's belief that supporting designers *'internal look-up tables' (*Appendix Fp103.) is an important to improving colour in DTP. Many didn't use specific colour management practices preferring to use *designer's eye* to gauge colour through carrying out colour sampling. Designer Consultant A rather than relying on colour data talked about her method as *"I'll get to know the different colours that we're working on and what to do with them"* because "*it's too expensive to get it wrong*"(Appendix F p39-40.). In describing her colour knowledge she said, "*myself conviction as a designer is that I have a particular colour vision and relationship with colour and luminosity"* (Appendix F p45.).

This theme of inner colour knowledge was also brought up by Emma Kendall, recent Textile Graduate, who spoke about the contention between colour data and visual observations *"because if every colour has an RGB value and it is made up by a mathematical formular, then that is the colour, that is the colour it should be and it's just the translation from screen to your eye is lying…your monitor should not lie to you" (*Appendix F p62.). Studio Flock spoke about the issues of not having textile Know-How when using DTP saying, *"a lot of my designers…are not from textiles at all so they don't have any knowledge of this (textile characteristics)"*(Appendix F p71.).

Jacqueline Milton spoke about the challenges of colour consistency, with the same design printed by different DPBs looking very different from *'pale and washed out'* to having a *'yellow tone'*, despite the CAD file being the same (Appendix F p83.). Trish Belford responded to say that "*designers probably don't have the necessary equipment to get correct colour matches"* (Appendix F p126.). Colour choices and influences were also varied ranging from photography, designer's eye, trends, yarns, sketches, and colour chip references meaning that the wide range of colour sources needed to be considered.

Melanie Bowles, Academic and Researcher of DTP, spoke about collecting colour "*through finding colour, this can be object's or flat colour as well as yarns. I arrange them to make palettes"* (Appendix F p115.). But again designers' colour familiarity was cited as useful, for example Melissa Ougham, recent Textile Graduate, spoke about how "*to get accurate colours"* she'd print her palette and "*if I knew I wanted a blue or wanted tone of that blue I would just go up and down on that colour spectrum"* (Appendix F p97.) until she achieved it. Phil Henry, Academic and Researcher of Colour in DTP, voiced concerns that the challenge would be exacerbated by '*software and product development' being 'driven by technology'* so that *'we will continue to see brighter monitor displays that can visualise broader ranges of saturated colours rather than demonstrating physical possibilities'* (Appendix F p101.).

Textile Technician Kenny Taylor provided RGB swatches for students to use for colour matching but advised against "*relying too heavily on colour swatch books at they can fade, and the outcome can still shift with different printers"* (Appendix F p111.). Rachel Reynolds, Textile Technician, got her students to "*steam and wash"* to fix issues, citing *"black can be an issue when printing"* but requires fixing through secondary processing *"correctly for…beautiful results*" (Appendix F p121.).

These conversations highlight that colour matching in DTP is challenging for designers. From these conversations the key problems are summarised in Table 5.

Reducing or controlling colour fidelity variables
The majority of designers interviewed reduced colour fidelity variables by working with one substrate, or a limited number of substrates, which enabled them to build up a colour knowledge-bank in order to make adjustments to the digital files which accommodated colour changes caused by the structure and composition of the cloth.
Designer and printer communications
Several designers had developed good working relationship with a particular digital print bureau having trialled several bureaus and encountered issues such as colour mismatches. Reduced costs or free colour sampling, good colour management communication, such as providing an ICC profile to embed, and consistent results were all cited as important when out-sourcing digital textile printing.
Designer's eye
All the designers made tacit adjustments in their digital files to allow for colour changes between screen and print-colour. These adjustments were made based upon past experiences, built up tacit knowledge and intuition, as well as digital colour knowledge. Designers talked about adjusting levels, saturation, brightness, mid-tones, and shadows to control colour.
Colour management education and accessibility
Established colour management practices such as ICC profiles, working in specific colour spaces and colour measurement procedures, for example, using a spectrophotometer, utilised by the graphic and photographic industry for digital paper printing, do not appear to be the primary source of colour control for designers working in this medium. Several of the designers were not aware of these processes or did not understand them. The majority did not have access to colour measurement technology such as a spectrophotometer or bespoke digital textile printing software. The designers who did incorporate these controls had greater industry experience, combined additional tacit adjustments on top of these practices and incorporated customised ICC profiles for their print environment.

Colour testing
Colour sampling and colour palette testing was shown to be a simple yet useful and accessible method which designers incorporated into their design process. This visual process built up Know-How of digital colour and colour changes.
Entrepreneurial business models
All the designers interviewed felt that DTP had enabled and empowered their business model. Designers cited small print runs, reduced overheads, quick turn-around times, and the ability to respond quickly to design trends as reasons for engaging. Many liked the ability to produce innovative and customisable fabric designs for a small, or specific, market which allowed them to test out design styles without the risk of having to hold large amounts of stock which they may have to scrap or reduce if unsuccessful.

Table 5 Themes arising from Colour Conversations

3.12.2 Review of strategies used to improving colour outcomes in Digital Textile Printing which supports themes from Colour Conversations

Whilst official best practice guidance from industry bodies is lacking[53] the review has collected advice encountered through undertaking the Contextual Review.

Polston et al (2015) discovered that users of DTP whilst lacking experience were keen to engage with the technology because it was convenient. These users blamed themselves for differences in colour or accepted colour differences as part of the process. Polston's study proposed that the SMEs and freelancers would be the drivers behind the future evolution of DTP because of their willingness to try out new products and techniques. They noted that colour charts were not used for colour sampling because users were unaware of the method and because colour matching wasn't of priority.

Polston's study recommends three-techniques to control colour outcome. Firstly, reducing the number of colours in the design in conjunction with using a colour chart which incorporated colour data. Secondly, experimenting with colour tools in software to alter the balance and temperature until a desired affect is achieved. Finally, a trial-and-error proofing

method was recommended where the design is printed, and corrections made on screen before reprinting until the outcome is satisfactory.

Briggs (2013) *how-to* book gives conflicting advice by stating that DTP has no colour limits but later indicates that colour matching is problematic. She endorses using manual adjustments, colour testing or drawing upon colour management software tools to achieve accurate colour outcomes.

Green (2010) recommends testing grey tones as the best way to assess colour output. He asserts that this is due to using equal combinations of the primaries which make up greys, ensuring that changes made to grey will affect all colours equally quickly highlighting colour differences and which colourant may need to be altered. Similarly, Belsham (2017) suggests that testing black generation will be the key to obtaining accurate colour outcomes.

Fraser (2004) cites Grainger rainbows as a useful method of establishing the gamut of a screen or print, an example is shown in Figure 23. A designer could print a Grainger Rainbow as part of a colour sampling method. Both Green and Fraser recommend standard colour management practices such as regular calibration of the print environment including the computer screen and proofing in controlled conditions, for example, retaining the same lighting conditions for working with digital colour and print. They suggest waiting for equipment to properly warm up before conducting assessments and investing in specialist equipment such as a spectrophotometer. Likewise Leak (1998) calls for specialist equipment in collaboration with increased knowledge about colour, in particular digital colour so that designers can make informed choices.

Figure 23 Gooby, B. (2020) Example of Grainger Rainbow.

Kelly (2014) advises test printing on a small scale. She recommends the tests contain the colour palette of the design with different variations, returning to the CAD to select the variation that most matches the expected outcome. She advises using a reduced colour palette and working in layers so that areas can be easily selected and altered during the colour testing process. She cautions that this will be challenging with photographic and tonal imagery. Kelly's advice was corroborated by designers with industry experience who she interviewed. They highlighted colour sampling, using specialist textile software, and retaining layers as key to obtaining better colour matches. Alterations carried out by DPBs to correct colour included varying post treatments such as steaming and ensuring that colour assessment was carried out on fabrics once they had been thoroughly dried and left to settle aided profiling.

McKeegan (2017) believes better communications between designers and DPBs would aid colour outcome. She calls for both printers and designers to find a common language to understand each other and improve the print process. Ross (2018) cited three cases where the printer could not achieve the correct colour outcome because either a colour was unprintable, and the client should have been informed, or because the print environment was not operating at best practice colour management standards. McKeegan advises designers to work in an Adobe RGB ICC profile colour space and at a high resolution to keep their options open and to be careful and selective when choosing their DPB.

Ding (2016) calls for improved standardisation in all the processes that impact colour outcome in DTP including textile chemistry citing lack of testing and procedural standards for the many colour challenges and variation across the industry. Additionally, she asks that future research takes a holistic approach, considering all the variables and their relationship, especially the substrate, textile chemistry, colourants, software, and hardware.

A survey of tools and products conducted as part of the project produced the following table of recommendations by the inquiry as per Table 6.

Table 6 Recommendations for colour tools and practices for designers and SMEs using Digital Textile Printing

	Level 1 Basic **For freelancers, individual designers, students**	**Level 2** Advanced **For design studios, SMEs, businesses working with suppliers, digital print bureaus**
Colour Library	• Use Colour Picker tools in design software to access colour data and free services such as Adobe Colour. Gain an understanding of different colour spaces RGB, CMYK, LAB and commercial colour libraries e.g., Pantone© • Might need minimal subscription services such as Pantone© Connect or Pantone© Live to access further colour references. • Consider colour apps which can match colours from photos and images to colour data for example Techkon Capture. • Ask DPB if they supply a printed or digital colour chart – get a physical copy printed on the fabric(s) you work best with or a cotton satin and have colour data recorded on it to help you match to digital artwork.	• Purchase physical and digital colour swatches or create a bespoke set with your DPB or your printer • If using Colour Management software use this to create digital and physical colour libraries. • Subscription services such as Pantone Connect or Live and wider Adobe Colour account services • Consider having a set of swatches for different fabrics
Colour Management	• Set a screen profile suitable for working environment. • Use Granger Rainbow method to assess screen colour range and compare to printed sample • Examine fabric samples in a consistent environment and keep records about time of day and background environment whilst wearing neutral clothing. Use a piece of grey card cut out as a frame to view samples through to neutralise your colour perception • Use ICC profiles in design work to ensure best conversion and create proofs. • Ask DPB what profile they use and what profile they recommend artwork has assigned.	• Purchase a basic colour management tool-kit to be able to calibrate and measure colour aiming for a closed loop colour environment (where all devices are integrated, and colour controlled) • Regularly calibrate and create profiles for your unique colour environment

In summary, the design community faces challenges and uncertainties when dealing with colour in DTP. Many are prepared for printing variables and inconsistencies of textile characteristics. However, the experience of industry experts showed that even with commercial experience and knowledge of colour management achieving accurate and consistent colour remained a challenge, and a universal resolution remains elusive. The proposed five significant challenges for colour in DTP contribute to the complexity of the colour problem. However, designers' expertise and skills enable them to employ solutions such as software adjustments, colour sampling, using their *designers eye* to navigate colour intricacies. Nonetheless, there is a need for a comprehensive and accessible tool-kit to aid designers which captures foundational information and builds upon designers' existing colour knowledge to support them in achieving more consistent and accurate colour outcomes.

3.13 Colour Ontology

In understanding the colour problem and the tools for preparedness, it has been established that the nature of colour is complex and multifaceted. As stated, the investigation adopts a pluralist realist standpoint as ascribed by Mohan Matthen (1953-) and has evolved from the theories of David K Lewis (1941-2001), to acknowledge the existence of these multiple realities of colour, both subjective and objective. Despite early divides about the reality of colour (Kentsis, 2005) the concept and sensation of colour may be described through phenomenological and explanatory approaches. Colour studies, therefore, comprise subjective perceptions of colour and objective physical properties. Thus, colour is measurable and relative.

In *Naming the Colours* (1997) Lewis proposed that colour could be defined separately and as a combination of subjective and objective terms 1) as a surface property which causes the experience of colour in human colour vision, and 2) the experience of colour as an inner state from viewing an object with the surface property (Lewis, 1997). Matthen raises many questions about Lewis' premises because for him the schema fails to account for variations of texture and changes in viewing conditions. Therefore, Matthen, argues for pluralistic realism which can account for variability saying that '*apparent variations in colour reports need not be taken as conflicting with another, they can be explained by the fact that people are not really talking about the same thing*' (Matthen, 1999 p72.). This is because there is not one method that can represent the experience and structure of colour and ultimately different approaches can provide information about one element of colour.

Furthermore, colour has a relational aspect, as attributed to Jonathan Cohen (1969-), in that there is an influential relationship between the perceptual processes of the observer, whose idea of and experience of colour shapes the appearance of colour qualities of an object within the external world (Cohen, 2009). Cohen explains that colours should be '*constituted in terms of some relation between (inter alia) objects and perceivers*' (Cohen, 2004 p452.). Thus, like Matthen, he sees colour as being the reality of a combination object's property,

the viewer, and the viewing conditions. For Cohen this premise is more important than considering any phemenological or relative approach to describe it.

The premise of fostering the inquiry's *anything goes* approach to colour, arose from a review of colour theorists at the outset which considered the variety of propositions, to determine usefulness and appropriateness for the inquiry. In conclusion it was found that there is not a single method of colour classification, nor a set of comprehensive principles to be appropriate for every field. Therefore, specialist colour structures have been developed (Best, 2012) as a desire, however ambiguous, to order and systemise colour. This wealth of colour material is confusing and makes it difficult to ascertain what is useful (Batchelor, 2008). Hence, given the multiplicity of possibilities in colour, achieving precise colour control becomes unattainable and so using flexible and adaptable approaches proves to be valuable in this context.

Colour is a valuable tool and has been used by humans to communicate with, aid the organisation, and as a means of decoration and playfulness (Hurlbert and Ling, 2017). However, the exact reason for human colour vision remains unclear as it is not needed to sense movement, form, or distance (Mikellides, 2017). Human colour vision may have evolved to aid foraging and sensing danger (Mikellides, 2017). Nevertheless, colour is widely incorporated across all aspects of human activity, highlighting its significance. Matthen describes colour vision as *'colour catching'* as opposed to '*colour generating'* ((Matthen, 1999 p73.) and as a mechanism to '*enhance visual discrimination abilities which are already in place'* (p75). He points to the usefulness of colour to humanity in being as a mechanism to categorise, but that as we can only systemise colour in terms of multiple propositions, he concludes that *'colour is a disunity'* (p84.). Lewis also states that colour categorisation must be seen as subjective due to its basis in colour experience and, thus, should be seen as the preferred construction of order, rather than colour objectivity, even within colour science (Lewis, 1997).

Thus in considering the reality of colour and consequently, colour reproduction, the inquiry has focused on ontological concepts of colour perception and colour categorisation,

interweaving knowledge on these to present an understanding of the colour problem and tools for preparedness. Overall, colour perception is a multidimensional and intricate field of study encompassing scientific, artistic, and cultural aspects. It involves understanding human colour vision, computer colour vision, colourimetry, colour idiosyncrasies, and the interaction of colour with materials. The interlinked concept of colour categorisation is therefore humanity's endeavour to group and order colour perception. While various specialist colour spaces have been developed to aid colour organisation and communication, such as colour science colour systems, models, and spaces we can see this endeavour to group colour in the undertakings of several practitioners who have developed their own systems for categorising colour. For example, Tauba Auerbach created a book depicting every single colour in the RGB colour model[54]. Le Corbusier created two sets of colour keyboards which used subtractive colour mixing to provide a selective colour space for interior design, with specific advice on colour harmony[55]. Ann Veronica Janssen created an immersive colour space using cyan, magenta, and yellow mist which visitors could walk through and observe colour mixing[56]. Similarly, Olafur Eliasson, created *Your Atmosphere* which also utilised coloured mists[57]. Thus, the interconnected concepts of colour perception and colour categorisation encapsulate the challenge of colour in DTP to encompass the scientific and creative difficulties.

The philosophies of Lewis, Matthen and Cohen further support the inquiry's findings that there are five significant challenges for colour in DTP. Some of these, gamut mismatches, numerous variables, and adaptions, are clearly part of the scientific aspect. The stance of pluralist realism and relationalism with regards to colour allows for the consideration of numerous parameters within the print environment and production conditions, encompassing both objective factors like colour management and colouration, and subjective factors like human colour vision. These elements contribute to the multiple possible realities of colour which, to paraphrase Matthen, are not in conflict, rather are not really describing the same thing. Outsourced process and inconsistent design education and standards might be positioned within the creative aspect, the variations in circumstances. Here the stance enables the embracing of the complexities and vast variations of knowledge and circumstances, acknowledging that colour is multifaceted and to recognise that each person's experience is unique. All of which makes achieving colour in DTP complicated, but

strengthens the premise that improving Colour Expectation, via enhancing colour expertise with foundational knowledge and visual indications of colour variations, is of value in this context.

These ontological concepts directly address the research questions in that the measures that designers must take (RQ1) will need to be informed by the understanding that colour is multifaceted, and that subjective, objective, and combined approaches will be valid. Furthermore, that multi-dimensional factors within the print environment and production processes ultimately lead to colour being uncontrollable and so comprehending how colour outcome might be influenced, and the scientific theory underpinning this, will be of use. Here, for the designer, it suffices to acknowledge that these factors impact colour without necessarily quantifying their exact degree of impact.

3.14 Conclusion and next steps

To understand the colour problem, it is important to note that DTP, a novel technology adapted from reprographic and photographic printing technologies, represents a significant advancement in the printing industry. However, it is crucial to acknowledge that the original printing methods were primarily optimised for smooth, glossy paper surfaces, which differ significantly from the textured, woven fabrics used in textile printing. The interaction of light with these diverse fabric surfaces introduces a completely different set of variables that must be taken into account.

There are numerous variables to consider, including the selection of colourants and substrate choice, which impact considerably on the colour outcomes. One noteworthy challenge in the DTP process is that it is often outsourced to Digital Printing Bureaus (DPBs), which means designers are absent during the actual printing. This limitation hampers their ability to fully comprehend the technology and rectify or prevent mistakes during the print process. Consequently, there is a greater reliance on colour management techniques to ensure consistent and accurate colour reproduction but with a lack of standardisation and approved best working practices this can cause further challenges.

Further adaptions stem from textile chemistry developed for traditional printing techniques and compromised to suit DTP. In particular around the application of binders and thickeners which aid dye bonding in a preparation stage as a pre-coating rather than combined with the colourant to meet viscosity specifications of the print heads. Shifting to a two stage process has increased the risk of colouration mishaps (unsuitable coatings being used for particular fibres, additional influences humidity and temperature changes, fluctuations in steaming and washing processes). These considerations highlight the complexity of achieving precise colour control in DTP, as there are specific variables related to textile chemistry that need to be taken into account due to their significant impact.

Colour management plays a crucial role in controlling colour data across different devices in DTP. This process typically involves converting colour information from one colour space to another. However, a significant challenge arises from the gamut mismatch between the

colour space of the screen (where designs are created) and the colour space of the printer (where the final output is produced). Algorithms have been developed to bridge this gap, but currently are unable to accommodate the unique variables inherent to DTP, such as textile chemistry.

Overall, the complexities introduced by the diverse nature of textile printing surfaces, the challenges of textile chemistry, the limitations of outsourced printing processes, and the gamut mismatch between colour spaces necessitate careful consideration and adaptation of colour management techniques in the context of DTP. Addressing these challenges is crucial to achieving consistent, accurate, and visually pleasing colour outcomes in DTP and answer RQ1, *What measures must a designer take….?*

Considering tools for preparedness we have to recognise that In the realm of textiles, colour assumes critical importance, leading to the emergence of specialised terminology and practices aimed at supporting colour selection and production. However, design education tends to predominantly focus on subtractive colour mixing, which overlooks the significance of digital colour that operates on an additive model, and relies on designers gaining industry and commercial experience to accrue knowledge of scientific colour theory and production methods (RQ2).

Designers who engage with DTP employ various strategies to overcome colour-related challenges combining both objective and subjective approaches such as colour management practices, visual observation, colour sampling, reducing variables and trusting their colour expertise. However, they also acknowledge that navigating these issues remains a persistent hurdle in their work.

Strategies for addressing colour-related challenges have been developed and shared by various researchers. However, the complexity of colour, coupled with the absence of standardised practices and the multitude of production processes and tools available as potential solutions, poses a significant hurdle in finding a universally applicable solution.

The working practices and experiences of the industry experts in the Colour Conversations Case Studies underscore the importance of incorporating the voice of designers as *colour determiners* in both further DTP research and production development to unlock the creative potential of DTP as a catalyst for innovative and entrepreneurial design-driven business models. Furthermore these multiple perspectives mitigate the subjectivity of the positionality of the researcher to evidence the challenges of colour in DTP.

This chapter has presented the multiple ways of describing, measuring, ordering, and grouping colour and it is clear that there is not a universal solution to colour in DTP. In understanding that colour may be specified by multiple elements, using subjective and objective methods of description, the inquiry seeks to provide designers with an understanding that colour is multifaceted. Hence, due comprising of multiple possibilities, it is sufficient to know what influences there are within the print environment and production processes which impact colour outcome as opposed to quantifying these. Thus, flexible, and adaptable approaches are required and will be of value.

In light of this, the value and utility of a tool-kit (Aim 1) lie in its ability to offer guidance, practical examples, and foundational knowledge to navigate the subjectivity and barriers associated with colour assessment. By providing accessible and familiar measures, the toolkit seeks to empower designers to develop confidence in handling colour and enhance their colour expertise.

The modality of visual colour methods and outcomes of the experimental, as described next in Chapter Four, seek to expand on the strategies outlined in this chapter and explore many of the themes and concepts presented to address the complex nature of colour and colour reproduction and seek to develop new tools and methods for colour in DTP.

Chapter Four

Experimental

Chapter Four presents the research activities resulting from the propositional knowledge of Know-What works. Preliminary experiments explored the influence of variables on colour outcome which led to the evolution of a proposed modality of visual colour methods; A Colour Reference Book as a colour sampling resource which seeks to demonstrate screen-to-print-colour differences and further alterations when printing on different textile substrates, Digital Lab Dip Tests which seek present print outcomes digitally, to indicate how colours alter when printed on different textile substrates, and Visual Indicator profiles which seek to apply on screen overall colour shifts so that designers can observe how colours might alter dependent on their intended fabric. These methods aim to improve designers' colour expectation knowledge and enhance existing colour skills. Using an application of colour knowledge and employing a specific colour palette for testing, the British Interwar Case Study has evaluated the usefulness and value of the modality, and highlights the complexity of colour.

4.1 Introduction

This chapter discusses the activities of the research inquiry to supports a key component of this thesis and project outcome, Exhibition of Praxis, documentation of which can be found in Appendix C. It presents the use of propositional knowledge of Know-What as per Nelson's model. Underpinning declarative knowledge of Know-That is interwoven through-out to cognitively ground the research activities with external inquiry. A reflective journal on the praxis is included in Appendix D.

The chapter begins by outlining an exploration of variables to assess their influence on colour outcome. These preliminary activities progressed into the exploration and development of a core research Praxis. This work, a modality of visual colour methods consists of a Colour Reference Book, Digital Lab Dip Tests, and Indicator Profiles. The

methods aim to enhance colour expertise and address questions around the theme of improving Colour Expectation RQ1 and 2, and developing tools of preparedness which led to the Project Tool-Kit, Aim 1. Finally, the chapter documents the application of the modality using a real-world case study which concerns the second theme of Colour Archive test, and addresses RQ3 and 4 to achieve Aim 2 of producing a historical colour palette for testing. The chapter concludes by summarises the analysis and evaluation of conducting the experimental work and its relevance in addressing the research questions.

As stated in Chapter One the experiments used a Mimaki DTP as per Table 4 unless specified otherwise. This limited exploration to Textile Substrates from natural fibres; cellulose (cotton and linen) and protein (wool and silk) rather than synthetics, which are not compatible with reactive dyes. Observations were made using a Veri Vide Light booth CAC120 as per Table 3.

The relationship between the two themes of improving Colour Expectation and Colour Archive test

The two themes are linked through their mutual focus on solutions for colour reproduction in DTP with the Colour Archive providing the necessary materials for the colour knowledge which arose through the Colour Expectation element. Whilst the Colour Expectation theme exerted a strong influence on the inquiry, the Colour Archive was conducted alongside, and emerging insight incorporated. Furthermore, the Colour Archive seeks to make the findings of the research accessible to the intended audience as a tool for communication and acceptance, providing a practical example of application of colour knowledge and using a familiar technique for designers of a drawing upon archives and nostalgia for textile design inspiration (Guffey, 2006)

At the outset, experimentation arose from the colour correction working method of the researcher in professional practice, exploring colour corrective methods within design software and adjustment tools. For example, creating colour wheels as shown in Figure 24 and making incremental adjustments to saturation and vibrance settings. This was corroborated by some of the working practices of the industry experts from the Colour

Conversation series, described as *"the adventures of getting things wrong"* (Appendix F p38.) drawing on inbuilt sense of colour, built from experience. However, as a greater understanding of the different variables which influenced colour developed, the focus shifted to assessing their affect. Activity considered textile chemistry, printer processes and colour management to address RQ1 and RQ2.

Figure 24 Gooby, B (2016) Example of initial experimentation with APCC adjustment tools, printed on Cotton and annotated

4.2 Variable testing

There are numerous variables that affect colour fidelity in the digital textile print process which the Contextual Review, mode of Know-That, established are out of a designer's control and difficult to predict. An early identification of the variables was outlined as per Figure 13. However, Provost (2017)[58] ascertains that there are at least forty.

Selection of variables was made in relation to accessibility for designers, cost, and feasibility within the scope of the timescale of the project. For example, the possibility of changing the combination of dyes in the printer's ink set was considered to assess impact on print-colour using an alternative combination featuring orange and green, replacing red and blue. However, dye cartridges cost over £1600, and would require printer maintenance (a system flush through of all the print heads) leaving the printer non-operational for a period of time when required for other students. Hence, it was not possible to test this as a variable. Instead, it was noted that designers should ask their DPB about colourant set-up as this will impact ability to replicate hues. For example, a wider and more accurate range of reds and blues can be achieved if using an ink set with red and blue (Loser and Tobler, 2006). Such a limitation reflects the circumstances of the design community where many variables will be out of their control due to cost, skill set and accessibility and so, consequently, feeds into addressing what measures must a designer take (RQ1)? It was also felt sufficient to demonstrate that the variables had influence on colour outcome, rather than quantifying impact. This correlates with the reality of the scientific and creative aspects of non-reproducibility, where it is not possible to take account of the myriad of circumstances and thus navigational strategies hold value. This was further corroborated through feedback and critique where emphasis was placed on the importance of demonstrative and progressive experimentation as visual tools for communication and acceptance.

In order to achieve Objective 1, survey DTP systems, and 4, establish a body of DTP, the work of exploring key variables was broken down into a set of activities 1) Produce a body of work that explores, and tests ideas encountered through Know-That mode of knowing, 2) Produce a body of colour work to support designers' understanding of colour around these variables, 3) Gain an understanding of scientific and technological theory outside of the

researcher's Know-How, and 4) Evaluate the variables in the print environment to determine influence on print outcome. The output from this research is a body of work consisting of textile prints, samples, CAD files and sketchbooks which document practical experiments.

4.2.1 Profiling

Colour Management processes such as profiling have been developed to maximise a device's achievable gamut, i.e., a colour recipe, to transfer colour data between devices. The rationale for testing profiles was that a profile can be simply applied in design software, without the need to know how the profile was generated, or indeed specialist equipment to generate the profile[59] and therefore would be feasible and accessible measure for a designer to use to enhance printed-colour outcome and support their colour expectation.

After observing differences on screen, illustrated in Figure 25, from assigning different ICC Profiles to a specifically created colour test collage, the images were printed to observe whether the colour differences could also be seen in print, and to compare them to the screen versions. Observations and reflections were annotated on the prints and in a reflective journal. ICC profiles were developed for universal colour conversion (Green, 2010). The two most common virtual device profiles are Adobe RGB 1998, which represents saturated colours reproducible in photographic film, and sRGB IEC61966-2.1, which incorporates the colours reproducible by an average computer display. The experiment emulates an exercise carried out by Professor Carinna Parraman where a bespoke colour collage was digitally printed onto paper with different ICC profiles assigned and the results observed, and annotations made (Parraman, 2010).

The textile prints were made using an Epson Stylus DX8400, a standard desktop home printer, and pigment inks onto cotton. A4 postage labels were fixed to the fabric to feed it through the printer mechanism. A sample of the prints is illustrated Figure 26 which shows subtle changes in blue and red across the different profiles. The profiles assigned were the standard RGB virtual device profiles available in APCC. The colour differences in the prints were subtle but not imperceptible. The exception was Pro Photo RGB, a profile which

increases the overall saturation, which appeared to increase colour intensity and hue lightness both on screen (Figure 25, top row, fifth from left) and in print (Figure 26, bottom right)

The research concludes assigning different profiles will alter colour and is a measure a designer could take. However, a designer will need to understand the impact of assigning a profile to their CAD and should seek advice from a DPB on which profile to assign for their print environment. The research calls for the development of that profiles specifically for DTP which can incorporate data on textile characteristics such as weave, fibre type and textile chemistry, in addition for the introduction of profile standards in DTP from industry bodies.

Figure 25 Gooby, B. (2017) Image of a range of profiles assigned to a colour collage

Profiling was also raised in the Colour Conversations Case Study as a mechanism to control colour outcome, and as a challenge for understanding digital colour. For example Duncan Neil at Earthed Fabrics cited profiling as being part of his working practice. Talking about his experiences, he said *"sRGB has a really false kind of value of the depth of black… if you're ever doing anything that's got the sRGB profile the chances are you're picking colours that are going to be way off in terms of depth and strength, and out of possibility for any paper or fabric printer, so I always try and avoid that one, it might on screen make a design look great, but the chances of you hitting those, and getting the contrast that you're looking at, on fabric are really slim. Generally, if I am working in Photoshop, I tend to use generic Adobe RGB"* (Appendix F p22.). Design Studio, Blackpop, described profiling as '*really important*' as a means to "*match your profile with whichever printer you're using".* They use a profile provided to them by their DPB by request as "*if they're (DPB) not going to share their profile with you I wouldn't use them because…. You don't know what you're going to get at the end of it"* (Appendix F p17.). Digital Print Bureau, Be-Fab Creative recommended using RGB profiles for saving CAD work as *"RGB is a larger colour profile so if you put them (CAD files) in CMYK you would come out quite muddy"*. They spoke about how this differs to reprographics printing where CMYK profiles are recommended but cautioned that reduces artwork to a smaller colour space than digital textile printers can be capable of (Appendix F p10.).

Figure 26 Gooby, B (2017) A selection of the Adobe Photoshop Generic Profiles printed onto Cotton Satin

4.2.2 Multi-pass prints

DTP creates a print in a single pass, unlike traditional screen or rotary prints which print-colour in layers. The print head travels across the fabric depositing cyan, magenta, yellow and black colourant in a matrix of tiny dots which blend to a full colour print.

Thus, an experiment was conducted where artwork was printed in multiple passes. The designs were separated into layers in APCC. A primary foundation layer was printed, and the fabric fed back through to print additional layers. The prints trialled two techniques; a simple over print and colour separation print with deliberate overlapping to produce fugitive colours. A single pass print of both designs was made as a comparison.

The rationale for testing print passes came from two ideas, 1) that in traditional stamp printing, additional colours often occur where colours are printed in layers which creates a more three-dimensional aesthetic whereas DTPs are often criticised for appearing *flat* (Carden 2015), and 2) Parraman (2010) achieved enhanced colour outcomes through multiple passes in digital paper printing in her research practice working with artists and ink-jet printing. Both ideas substantiated the notion that colour outcome would alter when multi-pass printing in DTP. However, this measure would require the designer to work with the DPB as the printing process is typically outsourced. Some skill is required to get the design feed in line for consequential passes but there is potential to improve this using a customised feeder mechanism.

Observations of the prints revealed that colour differences appeared between the multi-pass print and the single pass print, especially with for the darker, deeper tones. For example, blacks appeared richer in the multi-pass print. This is significant as black is notoriously difficult to print using CMYK colourants as corroborated by the experiences of Designer Consultant A (Appendix F p38.) and Design Studio, Made in Brighton (Appendix F p86.). The multi-pass print are shown in Figure 27, and details in Figure 28, focusing on the black. However, paler colours such as yellows lost prominence as darker tones dominated

or were lost when over-printed. Additional overprint colours formed where the passes overlapped which appears to create a three-dimensional effect.

The change in colour appearance was presumed to be due to an increase in dot density from additional dye application and overprint colours. The increase in dye usage introduces additional expense and may cause issues with over saturation, wicking and colour consistency. Therefore, the research concludes that darker colours are perceived as richer when printed in several passes and that additional colours created by overlapping print passes offer artistic potential but would be challenging to produce economically viable or consistent prints suitable for the textile industry.

Figure 27 Gooby, B. (2017) Multi-pass prints top to bottom double pass print, triple pass print, single pass print

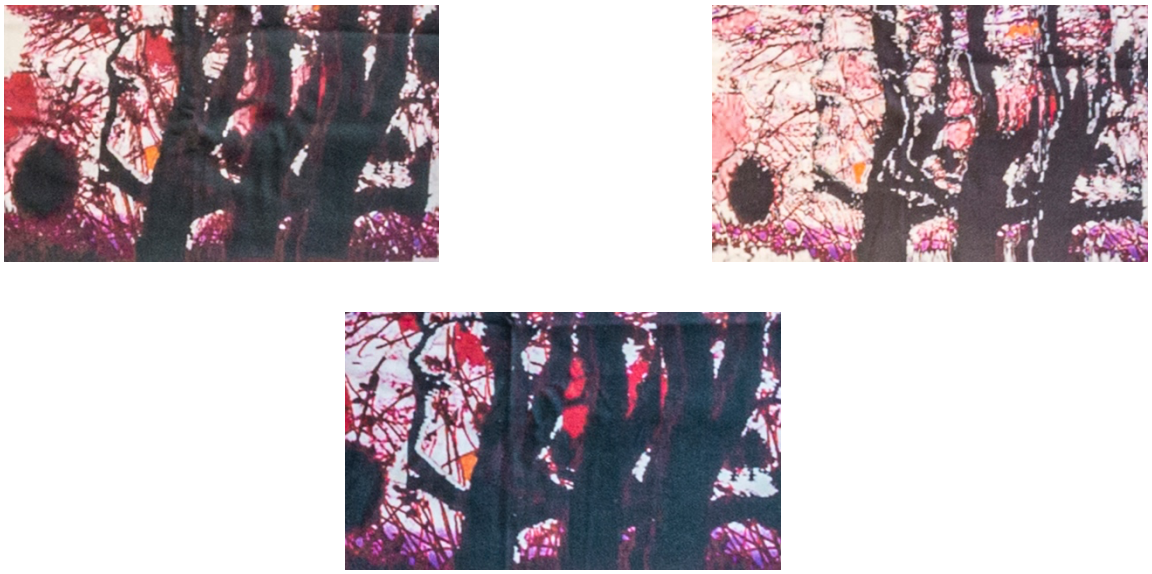


Figure 28 Gooby, B (2017) Details of the different blacks created by the multi pass printing Top Right, Double Pass print, Top Left, Triple Pass Print, Bottom Single Pass print

4.2.3 Textile chemistry

Variables that affected the textile chemistry were widely cited as being significant in relation to colour (Provost, 2013). Therefore, experiments were conducted which explored the impact of pre-coatings, and the secondary process of steaming post printing to determine the influence on colour outcome.

Industry experts in the Colour Conversations Case Studies cited the textile chemistry in secondary processing as frustrating, causing problems with consistency, and as the most likely part to affect colour outcome. Made in Brighton, Design Studio, reported experimenting with steaming times to get better colour results (Appendix F p85.), and Duncan Neil at Earthed Fabrics, spoke about how "*if something doesn't look right at the end, I'd always be wondering about the steaming first and then the wash"* (Appendix F p26.). Digital Print Bureau, Be Fab, described an experience of using poor quality pre-coated fabrics where the heaters used to dry the fabric had been faulty causing the coating to degrade and affecting the print-colour outcome on parts of their printed fabrics saying, *"there's been a lot of variables come from the coating side of things"* (Appendix F p7.). For example, the company they bought universally pre-coated fabric from *"using the same*

coating for all their cottons, and linens and silks, but some of them had more waxy surfaces and need longer for steaming" which Be Fab weren't informed about. This led them to believe that having bespoke coatings was more useful, saying *"you don't necessarily have control unless you're doing that (coating in-house) process"*. Melanie Bowles, an academic and researcher of DTP, cited the environmental factors of post processing (textile chemistry) as being a key cause for changing colours in DTP (Appendix F p113). Rachel Reynolds, DTP technician at Winchester School of Art, responded to say that secondary processing was undertaken by students to give them specific experience of how this affects printed-colour outcome (Appendix F p121.) due to its impact. Earthed Fabrics who used a bespoke coating for their linens, found it enhanced and improved colour control.

Fabric pre-coatings

Digitally printed fabrics require additional pre-treatments (Hawkyard, 2006) in preparation for print. The basic chemistry for these pre-coatings, sometimes described as a pad liquor, is adapted from knowledge of the binders and thickeners used in traditional dye and print pastes (Hawkyard, 2006). The addition enhances the resulting print-colour quality, and provides fixative properties for end-uses. Different coatings are required for different fibres, and further variations needed depending on the colourant (reactive, acid, disperse dyes, or pigment ink) (Hawkyard, 2006). Typically these are included directly in the print paste, however, restraints around viscosity and stability required to obtain precise dot droplets from the print head precludes this practice in ink-jet printing. In addition, the binders and thickeners tend to dry out, clogging up the print heads and degrading the print machinery (Dawson, 2000). Therefore, fabric pre-coatings are applied to the entire substrate in a separate preparation process via immersion, spraying or screen printing (Provost, 2013).

The rationale for testing this variable came from two ideas 1) a research project by Gearing and Stack where they digitally printed onto existing clothing, Victorian lace garments, after applying a pre-coating mix (Isaac and Bowles 2009), and 2) data-gathering which revealed that the pre-coating was significant in terms of achieving colour outcome. This measure involves a familiar process for designers from a textile education background as the ingredients are widely used in mixing up dyes and print pastes. Furthermore, the ingredients

were accessible (widely available and cheap) and could be mixed up at home. Therefore, whilst this measure would require skill and Know-How, pre-coating fabric for DTP could be replicated by a designer. Additionally, foundational knowledge of the influence of pre-coatings would enable designers to question DPBs about how fabric sourcing and their method for pre-coatings.

Figure 29 Gooby, B (2018) Documentation of creating the pre-coating mix

The research compiled a list of fabric pre-coating recipes and devised a universal recipe using a mixture of 20g Soda Ash, 33g Urea, 1Ltr Water (hand warm temperature) and 15g of Manutex. These were combined and blended in a mixer, as per Figure 29. A decision was made to use the same coating recipe for all four substrates after consultation with the specialist textile technician, with the rationale that a universal method would be a more accessible measure and that it was sufficient to determine colour influence rather than an exact method due to the number of variations in fibres and substrate construction . However, as outlined, data-gathering and the experiences of industry experts established that specific coating recipes (by fibres and colourants) enhance dye uptake and colour fastness. Thus, further research would test a variety of mixes, specific for each textile fibre using iterative methods.

The coating was applied to a range of untreated substrates (cotton, wool, linen, and silk) using different application methods, screen printing, spraying, and dipping. An area of fabric was left untouched as a comparison. The fabrics were printed, and a visual comparison made. The untreated areas appeared to show a lack of definition, print quality and colour

take up in comparison with the treated areas, particularly for the cellulose fabrics, cotton, and linen. Figure 30 presents details of the prints at the cross section where the coating was applied to the cellulose substrates, cotton, and linen, illustrating the clear impact of the coating to the colour outcome as the uncoated side shows a significant decrease in dye uptake.

Figure 30 Gooby, B. (2018) Detail of prints on coated and uncoated cellulose substrates

L to R: Cotton, left side coated, right side uncoated. Linen, left side coated, right side uncoated

Figure 31 Gooby, B. (2018) Detail of prints on coated and uncoated protein substrates

L to R: Wool, left side coated, right side uncoated. Silk, left side coated, right side uncoated

The protein fibres (wool and silk) were less affected in terms of colour uptake, but both fibres are known to absorb dye well (Ingamells 1997). Image quality appeared to be impacted, although more noticeably on the wool print than the silk, perhaps because of the differences in the tightness of the weave. Figure 31 shows details of the wool and silk prints. The dye uptake is very similar on both the coated and uncoated areas. A detectable

difference was observed on the wool sample, while no apparent difference was found on the silk sample.

The potential to produce creative colour effects by printing patterns of coating - leaving some areas uncoated, and some coated - was explored by screen printing motifs, using the coating mix, onto the fabric. These prints are shown in Figure 32 and Figure 33 which show a screen printed design of monster faces at the top of the two cellulose fibres, linen (top left) and cotton (bottom right). The uncoated area is in the middle and again there is a significant difference in dye uptake in the cellulose fibres, which is less apparent for the protein fibres, wool (top right) and silk (bottom left). The coating mix was also used to treat coloured cotton substrates to explore the influence of a coloured ground on colour outcome. The printed-colour was applied directly to the dyed fabric without the use of a discharge paste to remove the base cloth colour. These are depicted in Figure 34. The colour outcome of the prints onto dyed cotton produced some appealing effects - in particular the prints onto green and grey where the colour quality could be seen to soften and appeared aesthetically pleasing to the researcher. The saturated colours appeared duller, yet softer in comparison to the control print onto white cotton. The print onto yellow cotton appeared to have the greatest influence on colour outcome.

The research concluded that pre-coatings do influence colour outcome, and that this is enhanced for cellulose fibres, in keeping with textile colouration characteristics. The inquiry envisages that this measure could be utilised by the design community to exploit creative potential, and further explore sustainability potential from coating existing fabrics for reuse or customisation and could be combined with screen printing coatings to produce exciting design effects. In addition, as pre-coated fabrics are very expensive, coating your own fabric could reduce the cost of DTP for designers and students at educational institutes, thus increasing engagement.

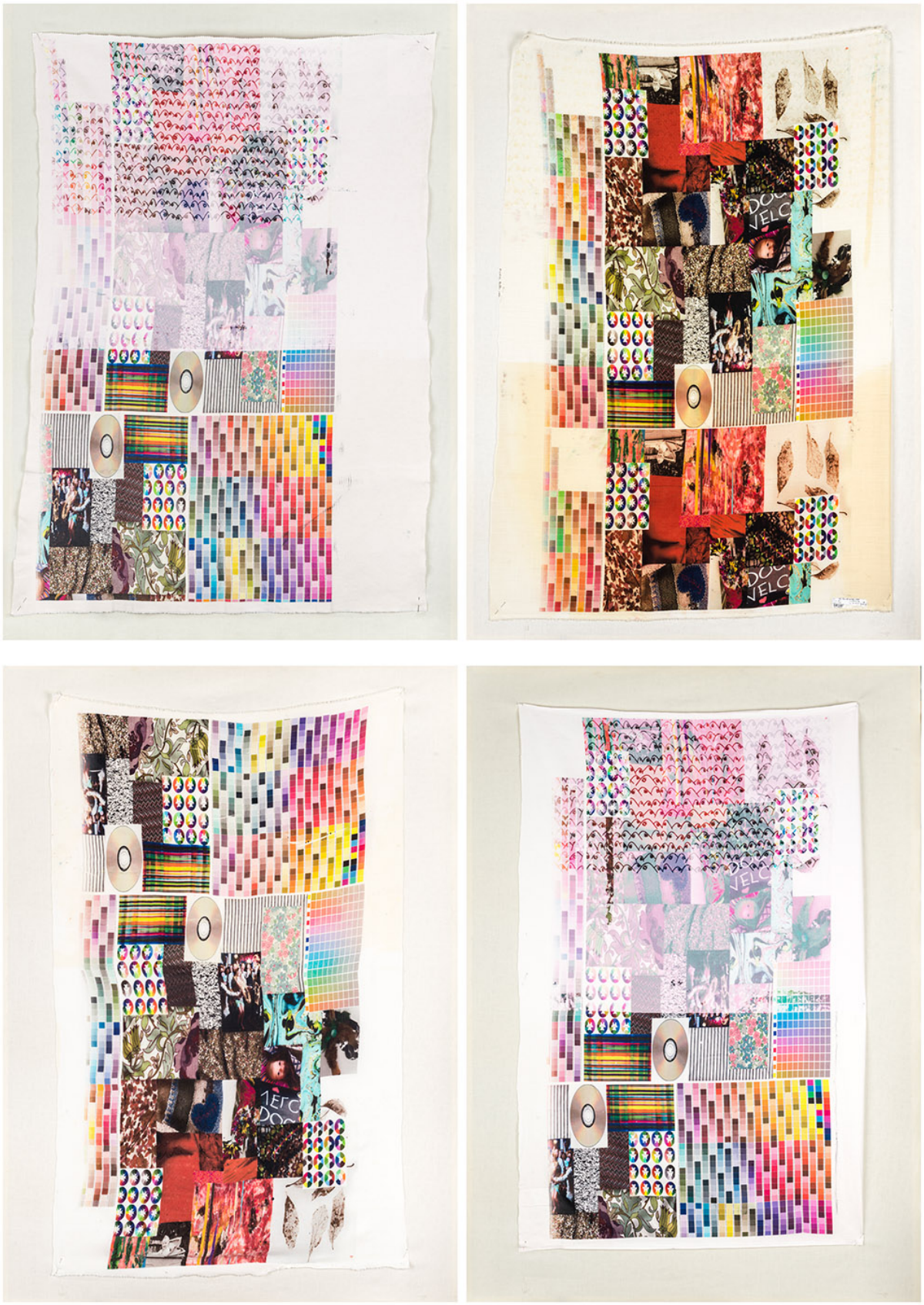


Figure 32 Gooby, B. (2020) First set of coated fabrics. Top row l-r: Linen, Wool. Bottom row l-r: Silk, Cotton

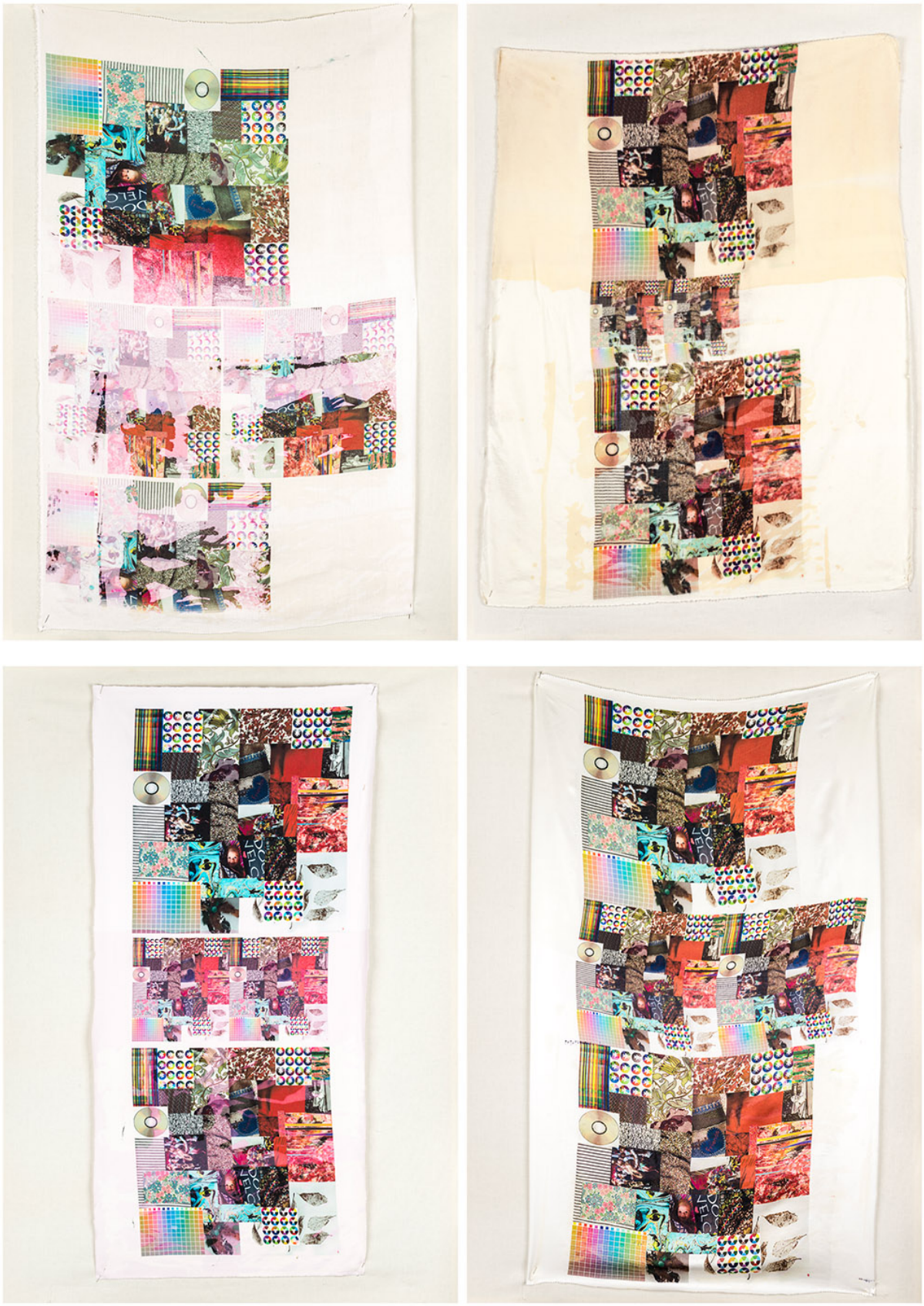


Figure 33 Gooby, B (2020) Second set of coated fabrics. Top Row – l-r: Linen, Wool Bottom Row – l-r: Cotton, Silk

Figure 34 Gooby, B (2020). Coatings on coloured fabrics

Steaming

The secondary process of steaming activates the coating chemistry to improve colour, fixation, and print quality (Provost,2013). To determine the influence on colour from steaming six test prints were made onto pre-treated cotton satin. Cotton satin was used as it had been observed, in preliminary experimentation, to provide the closest, visual colour match to screen-colour. The prints were steamed for different time periods before undergoing normal washing conditions, after which, a visual comparison was made.

The rationale for testing this variable arose out of a conversation with industry expert, Made in Brighton, a design studio with their own DTP print environment. Liz spoke about experimenting with steaming times after noticing differences to the colour outcome when this varied.

These prints are photographed in Figure 35. The shorter steaming times appeared to produce more vibrant colours, but the sixty-minute steam appeared to achieve the closest colour match to the screen. The longer steaming time, of one hundred and twenty minutes, led to dye bleeding. A print which was left un-steamed but washed demonstrated poor fixation. The print which was left un-steamed and not washed remained unfixed and the colours were appeared duller and darker presumably from excess dye was not being removed.

From these experiments it was observed that textile chemistry variables have a considerable influence upon colour outcome. A designer should be informed on the influence of textile chemistry and question their DPB about their pre-coating and post-printing practices to assess whether these are adequate, whilst also querying the textile chemistry when prints are returned with varying or unexpected colour outcomes.

Figure 35 Gooby, B. (2020) Steaming tests on grey backing paper Top Row L-R: 15 min, 30 min, 60 min steam Bottom Row L-R: 120 min steam, no steam & wash, no steam, and no wash

4.2.4 Summary

This body of work set out to consider a variety of ideas and theories to gain a comprehensive understanding of the influence that different variables had on colour outcome. The key findings from these research activities are that there are numerous variables that impact colour outcome within the DTP environment, many of which are out of the designer's control especially when production is outsourced. However, it is important for designers to be informed to support their ability to ask questions of DPBs and make choices about their print environment and end-product. The research calls for foundational knowledge on the influence of these variables to be included in design education on DTP

with an emphasis that consideration should be made for compromises made in relation to textile characteristics due to the adaption of colour management and textile chemistry for DTP. Additionally, it is worth noting that exploiting the colour influence from these variables could lead to creative potential for designers.

These experiments address the research questions around Colour Expectation, RQ1 and 2, by identifying measures that are within the control or potential influence of the textile designer, and are part of production methods underpinned by scientific colour theory. These experiments were progressive rather than iterative, although many of the tests were conducted several times. This was due to the substantial time and cost required to implement them and focus on visualising colour difference over quantifying them, corroborated by external critique.

The significant impact of the substrate

These research activities all revealed the significant impact of the substrate on colour in DTP as experiments included assessing more than one substrate type. Therefore, secondary studies were not felt necessary, as the inquiry prioritised demonstrating colour influence over quantifying colour difference. Accounts of the industry experts further evidenced the significance of substrate. They frequently cited substrate as a controllable variable or as an influence on print-colour. Trish Belford, a textile academic, wrote *"substrate always varies colour"* (Appendix F p126) in her questionnaire. Melissa Ougham, a recent textile graduate, spoke about how as a student she was encouraged to colour sample across substrates as part of her practice because *"different fabrics react in different ways to reactive dyes"* retelling about an experience where her prints on silk were *"7000 times brighter than whatever other fabric you were printing on"* and how this was tricky and would cause problems (Appendix F p97). Many industry experts spoke about how they retained colour control by limiting their fabrics. For example, BlackPop, design studio, printed primarily on Velvet, and Studio Flock, design studio, Linen, and linen mixes. Designer Consultant A spoke about adjusting colour levels, using *designer's* eye, depending on substrate. Be Fab Creative spoke about the challenges of printing on sheer fabrics and how the weave affects the print-colour because of the amount of ink that can be held by fibres (Appendix F p11).

Consequentially, the overall observation that substrate influenced colour outcome, corroborated by industry expert accounts, led to the exploration and development of a modality of visual colour methods which took the influence of the substrate as a major variable and sought to indicate colour alteration that occurred when printing onto four key textile substrates (wool, linen, cotton, and silk). These explorations are detailed in the next three sections.

4.3 Colour Reference Book

This research activity was an exploration of the Pantone© Colour Library: a digital colour reference tool used in industry to communicate and select colour in design. Many of the industry experts spoke about using Pantone© including Be Fab Creative, who used it for colour matching, but questioned it's accuracy (Appendix F p10.), Emma Kendall, a recent textile graduate, who wasn't taught to use Pantone at university but picked up the practice whilst working in industry, combining with RGB values for colour matching (Appendix F p57.), and Studio Flock, Design Studio, who used Pantone© references when sending files to her printer (Appendix F p66.).

Currently Pantone© offer colour system swatches printed onto cotton, nylon, and polyester but not silk, wool, or linen (Pantone. com, 2017). The swatches are dyed rather than printed. Several DPBs such as Spoonflower have a purchasable colour chart with corresponding digital colour data. A search of user uploaded designs revealed several colour charts recommended as designer reference tools with positive reviews and supporting the idea that this form of colour tool is helpful and aids colour expectation and assurance (Spoonflower, 2017).

To evidence that there is a difference between screen-colour and print-colour, and further variations between substrates; a colour chart was created in CAD, using the 1137 colours in the Pantone© solid uncoated colour library in APCC. The chart was printed onto four different substrates (wool, linen, cotton, and silk). Observations of the book demonstrated apparent differences between screen-colour and print-colour, as well as between substrates, particularly in neutral ranges[60] such as greys, blacks and browns, and colours from the blue and magenta tonal ranges. The numerical data (RGB, HSB, LAB, CMYK and Hex#) for each colour was recorded and compiled into a table alongside a paper print as the closest visual reference to the screen-colour. The table was digitally laser printed onto paper and the individual fabric swatches incorporated alongside.

The resulting Colour Reference Book, an example page from which is shown in Figure 36, appears to provide an indication of the shift from screen to print-colour, and a visual

comparison of colour differences between the four substrates. The body of work provides a broad range of hues and data for comparison. It visualises differences between the screen to print-colour, particularly in neutral ranges such as greys, blacks, and browns, as well as colours from the blue and magenta tonal ranges, for this range of Pantone© colours.

Figure 36 Gooby, B (2018) Example page from Colour Reference Book

Each row consists of the digital numeric values (RGB, HSB, Lab, CMYK and Hex) and indicates whether a colour is considering in the gamut of a generic CMYK printer (Y/N).
The swatches L-R: Paper print, wool, linen, cotton, and silk.

The creation of the Colour Reference Book set out to investigate several factors through visual and data analysis, the influence of substrate on colour, and the data behind digital colour creation.

The activities of the research activity can be broken down into 1) Create a colour chart for a wide range of colours, 2) Produce a set of data for each colour which would give a visual understanding of different colour spaces and digital colour creation, 3) Evidence that there are differences between screen-colour and printed-colour on fabric, 4) Evidence that there is a further colour difference between substrates, 5) Gain a comprehensive understanding of the Pantone© Matching System 6) Produce a visual understanding of how APCC maps a

colour when it is not in the gamut of a generic CMYK printer, and 7) Observe an example of Gamut Mapping process and consider effects of colour management in print outcome.

The outputs from this research activity are 1) Colour Reference Book (physical copy, electronic copy, and paper facsimile), 2) 4 fabric charts (wool, linen, cotton, and silk – with all 1137 colours), and 3) Data (Spreadsheets, Histograms, Line Graphs, and other data analyses).

4.3.1 Creation of Colour Reference Book

The introduction to the Colour Reference Book contains a step-by-step description on data gathering, which is illustrated below in Figure 37, Figure 38 and Figure 39. Additionally, further detail is provided in Appendix H.

Figure 37 Gooby, B. (2017) Screengrabs of APCC Creative Cloud 2015

Left: Screen shot of Pantone© solid uncoated Colour Library in Adobe Photoshop CC 2015. Right: Screen shot of Colour Picker in Adobe Photoshop CC 2015

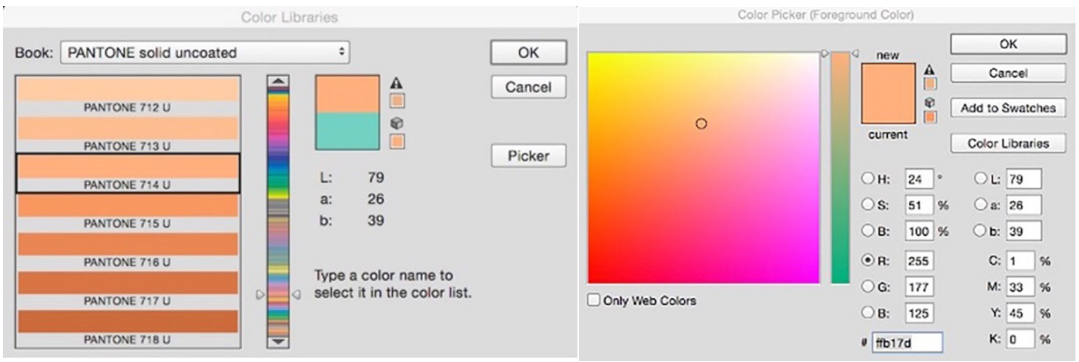


Figure 38 Gooby, B. (2017) Screengrabs of Adobe Photoshop Creative Cloud 2015

Left: Screen shot of Out-of-gamut Colour in Pantone© solid uncoated Colour Library in Adobe Photoshop CC 2015. Right: Screen shot of Out-of-gamut Colour in Colour Picker tool in Adobe Photoshop CC 2015

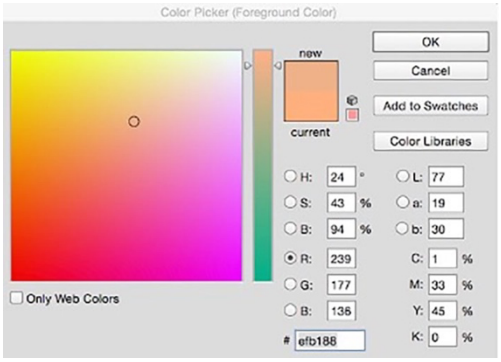


Figure 39 Gooby, B. (2017) Screengrab of Adobe Photoshop Creative Cloud 2015

Screen shot of mapped colour after selecting out-of-gamut colour warning in the Colour Picker tool in Adobe Photoshop CC 2015

4.3.2 Data analysis

Initial data examination revealed that 227 of the 1137 colours were considered out of the printable gamut of a generic CMYK printer by APCC's out-of-gamut warning tool. Of these 227, the majority were from the magenta tonal range (53 purple and 38 pink), whilst 46 were classified as green, 27 red, 21 blue, 20 yellow, 20 orange and 2 brown. These classifications were made by the researcher and so may be perceived as subjective. Observations of the mapped colour appeared to show that it was duller in comparison to the original, and frequently darker, when viewed on screen which was corroborated by examining the colour data[61].

4.3.3 Patterns in colour data

The numeric values (RGB, HSB, L*a*b*, CMYK and Hex) were examined to determine whether there were any patterns, or assertions that could be made, to whether a colour is printable and will be a good match to the screen colour. A set of parameters were identified, and questions drawn up based on the assumption that high values of certain data would cause conversion issues. The data was analysed using .xml code written by Dr Paul O'Dowd, and a set of histograms produced with the results. A synopsis is provided below and full detail in Appendix H. This analysis determined that a hue with a high red RGB value, 229 and above, would be likely to be out-of-gamut for a generic CMYK printer as per Table 7, according to the out-of-gamut tool. Colours with a hue HSB value between 252 degrees and 288 degrees, the blue to magenta range, were also likely to be considered out-of-

gamut. Likewise, bright colours, with a brightness HSB value of 80% and higher, would be likely to be considered out-of-gamut as per Table 8.

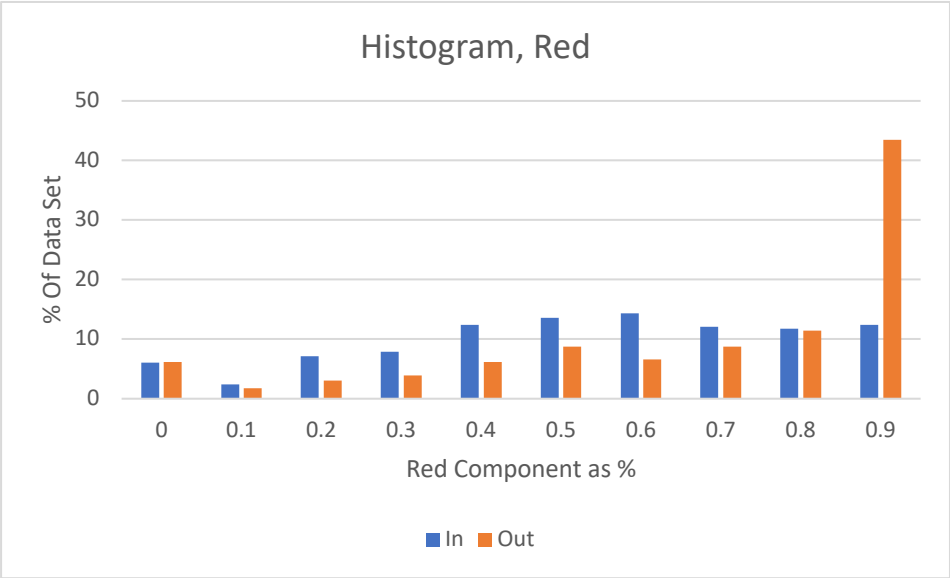


Table 7 Histogram comparing the set of data for colours (blue) and colours out-of-gamut (orange) and the proportion of red in their RGB value. The maximum amount of red is 255 and the minimum is 0. To make a comparison between sets the data was converted into

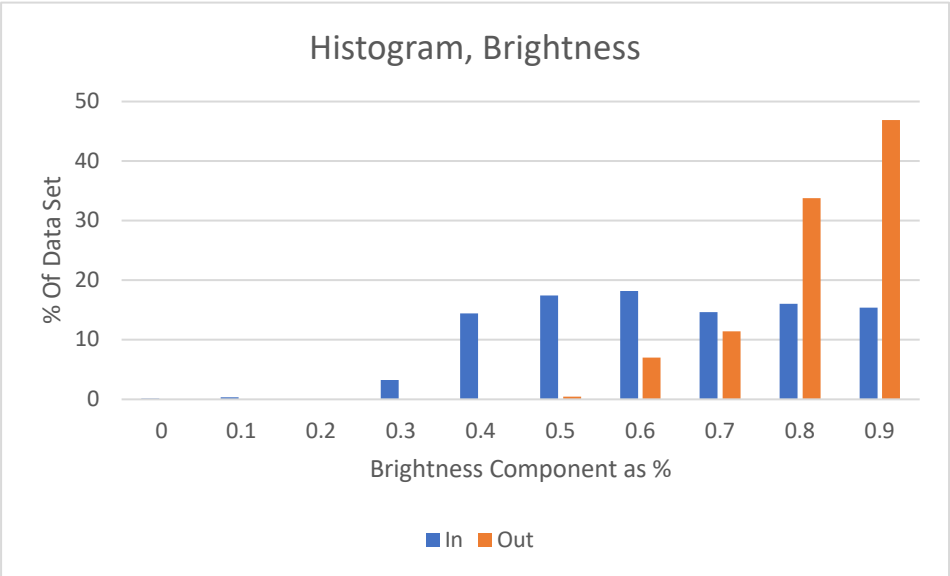


Table 8 Histogram comparing the set of data for colours (blue) and colours out-of-gamut (orange) and the changes in brightness value. Brightness is measured as a percentage.

This out-of-gamut set is of interest because, one presumes, that it is difficult to predict how these colours will print. Proving the hypothesis that high red RGB values and significantly

bright colours are out of a generic CMYK gamut, thus unprintable, indicates that designers may wish to avoid using overly bright colours or those with a large proportion of red if they wish to achieve colour fidelity. However, these findings did not tally with the results from visual analysis.

4.3.4 Visual analysis

Visual observations of the printed swatches showed that the neutral and achromatic colours - greys, browns, and blacks as exampled in Figure 40, differed widely between substrate and screen-colour, yet were shown as in-gamut in APCC. Furthermore, colours flagged as out-of-gamut did not differ widely in print from the screen-colour. For example, shades of warm reds and oranges were frequently flagged as unprintable, yet the printed-colour appeared a close visual match as per Figure 41.

Shades with a high magenta or blue undertone appeared to display a greater difference between substrate and screen-colour. Data examination revealed that some of these were flagged as unprintable by the APCC gamut warning tool.

In general all the prints appeared to display a reduction in brightness. Printed colour is subtractive (absorbed rather than reflected) and so a degree of loss of brightness is to be expected.

Figure 40 Gooby, B. (2018) Example page displaying achromatic colours. Top Row - Paper print, Row 2 Wool, Row 3, Cotton, Row 4 Linen, Row 5 Silk

4.3.5 APCC out-of-gamut warning tool

The above findings indicated that the APCC gamut warning tool is not an accurate indicator of whether a colour may print as expected and thus, the full data analysis from this exercise appears in the appendix as the hypotheses were not shown to be of value. This highlights how colour tools can be confusing to the user. The tool does not take account of other colour management processes in the print environment, nor can it consider additional variables that affect colour outcome reflecting the significant challenge to control colour in DTP due to numerous variables. The out-of-gamut warning tool is generic and so cannot account for variations in colour conversion algorithms or textile chemistry and so would not be a reliable measure for designers to use. In this instance, the print environment used a Raster Image Processor for enhanced colour conversion and an extended colourant set. This included red and blue dyes, widening the number of achievable colours and light cyan and light magenta, which ensures better tonal reproducibility (Loser and Tobler, 2006) unaccountable by the out-of-gamut flagging tool.

4.3.6 Substrates

The construction, or yarn and weave of a fabric, all affect the achievable colour gamut (Kim, 2006). Wool is a keratin protein, animal fibre which naturally repels moisture but does absorb dyes (Wilson, 2001). However whitening pre-treatments are complex so to reduce cost the natural yellow undertone is left which affects the printed-colour (Provost, 2013). The wool substrate used in this experiment is a twill with a diagonal weave and has the greatest texture of the four substrates. Silk is also an animal fibre, made up of 80% fibroin and 20% sericin proteins, and has comparable elastic properties (Udale 2014). Like wool, silk absorbs dye well, but is easier to whiten and the smooth texture and reflective qualities of the satin silk tested presumably contributed to the appearance of strong, vivid colour results when printed (Ingamells, 1993). However, whilst the colour was strong, the tone appeared to be frequently darker than the screen-colour. Linen, a cellulose fibre constructed from flax plants, does not absorb dye particularly well (Udale, 2014). The juniper linen tested has the loosest weave of all four substrates and natural slubs in the fabric can cause printing issues. Linen has a natural resin; lignan but does not repel moisture like wool (Ingamells, 1993). The colour match on linen appeared good, but the saturation was greatly reduced and the resulting shade less vivid than the screen-colour. The colour of the linen prints appeared to alter considerably during the secondary processes of steaming and washing to fix the colour, due to dye loss. Cotton is also cellulose; derived from cotton plants but absorbs and retains dye well (Udale, 2014). The cotton satin tested has a tight weave and smooth surface and appeared to provide good colour results - the closest to screen-colour of the four substrates. Like the silk, both the linen and cotton were bleached white in preparation for the print process. The substrates tested here were all purchased pre-coated.

4.3.7 Summary

The research findings seek to establish that the substrate has a great impact upon colour outcome, which corroborates accounts of the industry experts. The research envisages that the Colour Reference Book could be used as a resource by designers to get a sense of how substrates alter printed-colour, as a colour chart download, as a reference tool for examining and comparing colour data, and as an indication of colour changes across substrates to enhance colour expertise, highlighting visually, challenging to print colours.

Whilst it must be acknowledge that the Colour Reference Book represents a single instance of DTP, it seeks to provide a demonstration that achromatic colours and hues with a high magenta or blue tone are particularly problematic and thus, require careful colour testing. These colours were raised by industry experts as examples of tricky to print-colours[62]. Example pages, in Figure 41 , of red and green hues appear to show close matches across the substrates and the paper print, whereas the purple hues and neutral hues in the example appear to show poor matches.

Figure 41 Gooby, B. (2018) Example pages from Colour Reference Book

In conclusion, this activity appeared to affirm that exploring multiple colour possibilities is essential for examination since singular instances can only describe one aspect of colour as examinations of colour data and visual observation led to differing conclusions. This activity addresses the research questions around Colour Expectation, RQ1 and 2, to examine the different measures a designer might take, considering CAD software tools, colour sampling, examination of colour data and visual observation, to reflect on the underpinning theoretical concepts and production methods that the design community might utilise.

4.4 Colour Maps - Digital Lab Dip Tests

A series of indicator colour maps were produced using mean averages of hue, saturation, and brightness (HSB) value shifts for two sets of colours. Digitised swatches were plotted onto the colour maps to visualise printed-colour changes from the screen-colour. The digitised swatches symbolise a digital lab dip test and illustrate how a colour might be expected to print, depending on substrate, within this print environment. A lab dip is the term for a fabric sample used by the manufacturer to establish a colour match with the buyer's supplied swatch or colour standards (Best, 2012).

The maps offer visual prompts to allow designers to build their own '*internal colour look up table'* (Appendix F p103.), enhancing their digital print-colour knowledge and enabling them to predict and resolve colour issues during the design process.

The objectives of the research activity can be broken down into 1) Identify two sample sets of colours to provide a broad range of hues representing the spectrum, as well as challenging common and achromatic colours, reducing the need to measure the entire Colour Reference Book, 2) Produce a set of data for analysis through a colour measurement exercise, 3) Gain an understanding of colour measurement processes, 4) Gain an understanding of the light spectrum and wavelengths, 5) Evidence the difference between screen-colour and print-colour and the impact of substrate, 6) Produce a digital version of print-colour outcome, 7) Investigate and observe the difference between screen-colour and print-colour and the impact of substrate, and 8) Visualise the difference between screen-colour and print-colour and the impact of substrate.

The outputs from the research activity can be listed as 1) 192 Digital Lab Dip Tests derived from measuring physical fabric swatches of 48 hues. There is one digital lab dip test per colour, per substrate, 2) A set of Colour Maps for two ranges consisting of 48 hues. Each colour has two maps: Map One plots the colour difference between screen to print-colour as well as substrate, and Map Two displays an indicator print-colour juxtaposed with the

screen-colour as a reference tool, 3) A set of annotated wavelength charts and data analysis, and 4) A set of qualitative data and analysis.

Two sample colour sets were identified, decreasing the range from over five thousand swatches which would be time consuming to measure.

Set One

This set consisted of prints from the first 24 Pantone© colours representing a range of highly saturated, spectral hues - red to purple. These are shown in Figure 42.

Figure 42 Gooby, B. (2016) Set One First 24 Pantone© Colours

Set Two

This set of colours was taken from the Colour Tile, a colour rendition chart, used by Dr Philip Henry at the University of Leeds, for his ColourMimix[63] software (2013). Colour rendition charts were created as visual evaluation tools for the photographic, television and printing industries. They are made up of a set of essential colours based on RGB and CMYK primaries, and colours that are challenging to reproduce (McCamy, Marcus and Davidson, 1976). These are shown in Figure 43.

Figure 43 Gooby, B. (2017) Colour Set Two

The swatches were measured using a Kodak-Minolta FD-7 spectrodensitometer which returns sophisticated colour measurements using filters to measure the wavelengths reflected from the colour sample. The spectrodensitometer was set up to measure the reflectance value under D65 illuminant conditions; the standard for measuring textiles and return LAB and wavelength (nm) values from 380 to 730nm (SDC, 2008). The measurement exercise was conducted several times as some of the CIE LAB results returned varied and were not obvious matches to the measured swatch when the data was entered into APCC colour picker tool to visualise the swatch on screen. This highlighted to the researcher how colour measurement readings are not always reliable or precise.

The visible light spectrum begins at violet (400nm) and moves from indigo (445nm), blue (475nm), green (510nm), yellow (570nm), orange (590nm) to red (700nm) (Feisner and Reed, 2014). LAB values represent the colour space of human vision established by the CIE

International Commission on Illumination. The three values represent the hue lightness (L) and position on a red-green (a) and blue-yellow axis (b) in a three-dimensional model. LAB is a larger colour space than RGB (additive/screen) or CMYK (subtractive/print) and is device independent thus not reliant on print environment calibration Figure 44 depicts the colour space of LAB and Figure 45 depicts a generic CMYK colour space on the left and a generic RGB colour space on the right, superimposed over the LAB colour space to demonstrate how much larger LAB extends.

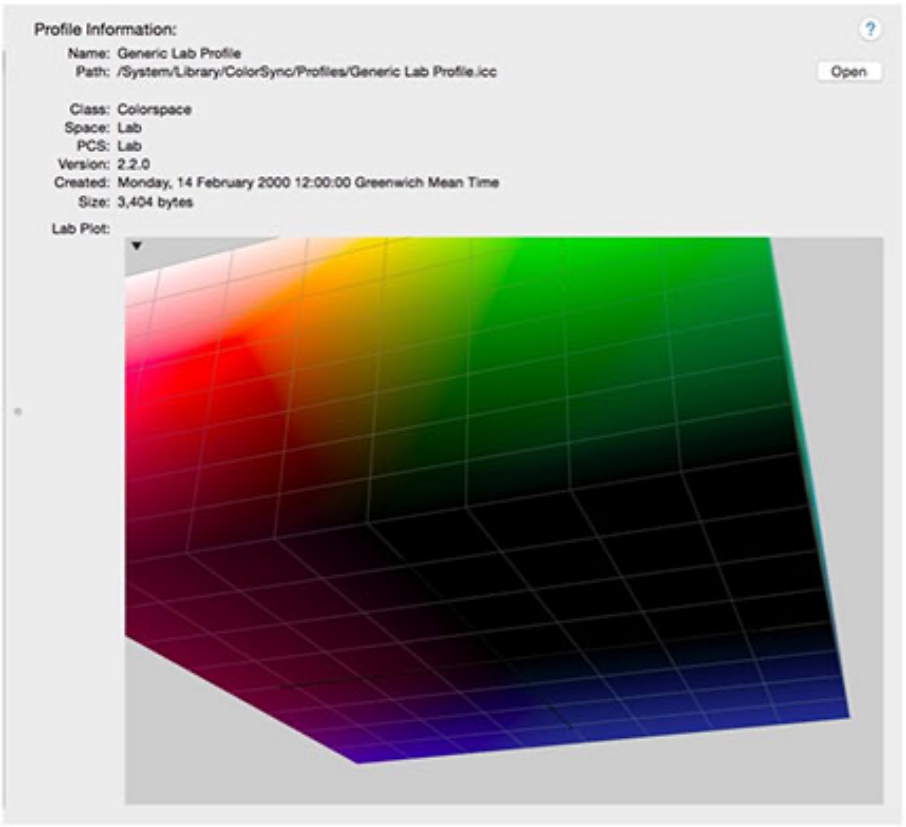
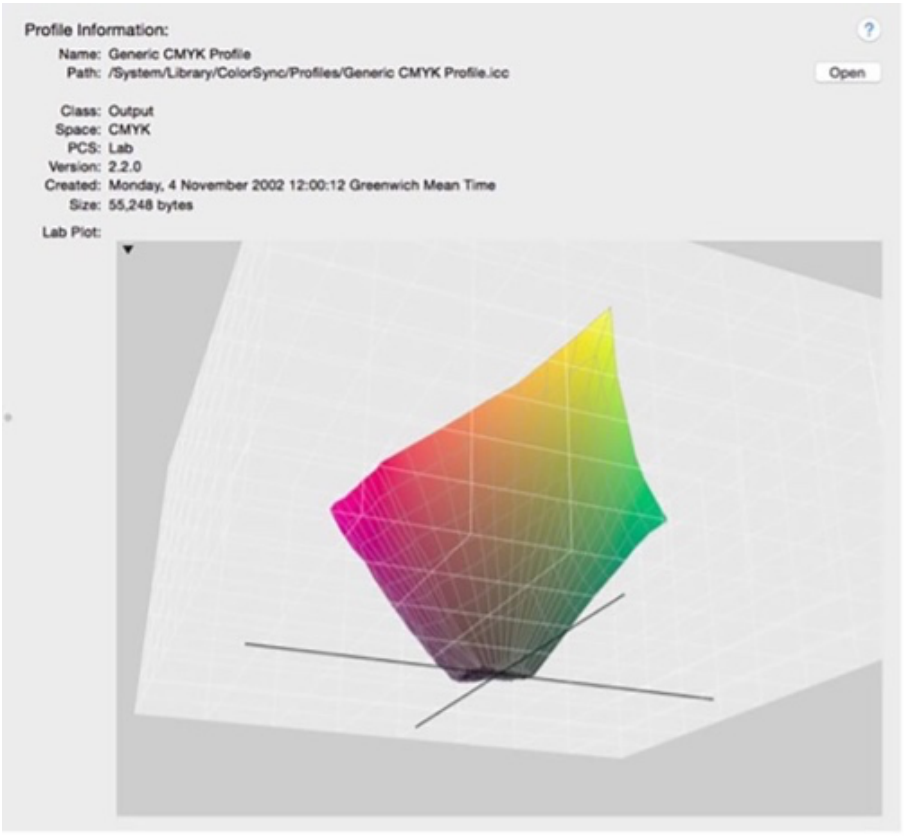


Figure 44 Gooby, B. (2017) Apple Mac ColourSync Screen Grabs

Apple Mac's ColourSync's representation of CIE LAB colour space



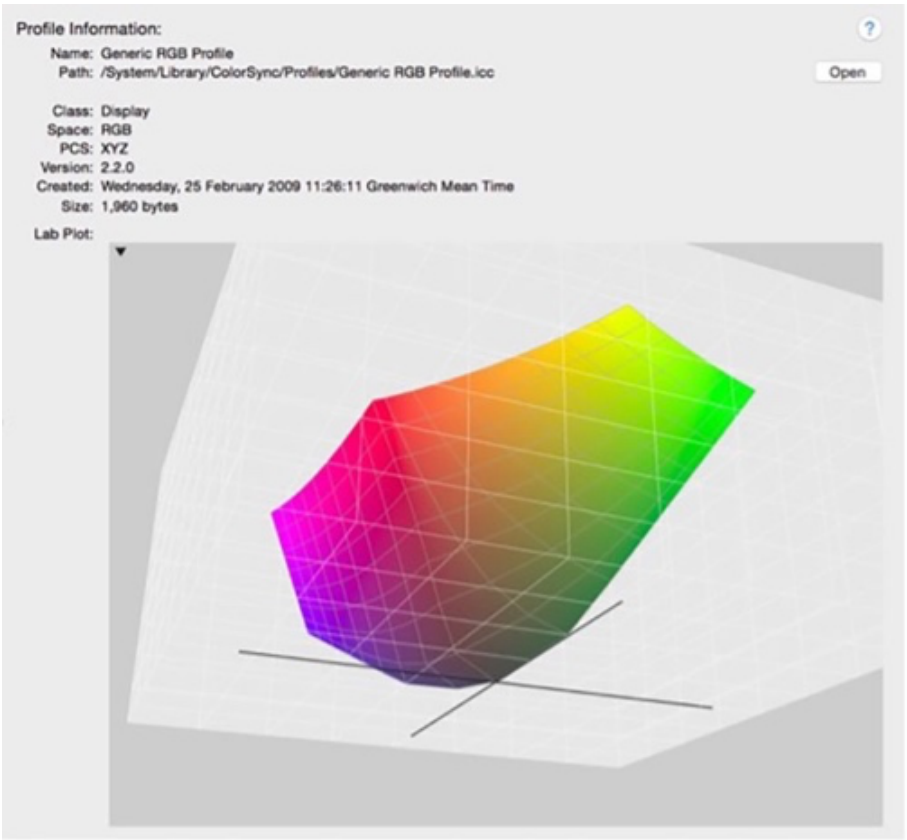


Figure 45 Gooby, B. (2017) Apple Mac ColourSync Screen Grabs greyed out area represents CIE LAB

Top: Apple Mac's ColourSync's representation of Generic CMYK Colour Space compared with Generic CIE LAB colour space. Bottom: Generic RGB Colour Space compared with Generic CIE LAB Colour Space. Both are shown to be much smaller than the Generic CIE LAB colour space.

4.4.1 Wavelength data

The wavelength values for each swatch provided by the spectrodensitometer were recorded as line graphs, and the changes in spectral ranges were noted. An example is shown in Figure 46, mapping the LAB data recorded for 08 Purple from the first set being examined, of spectral saturated colours. Comparisons were made against the paper print. A pattern emerged where the fabric prints had lower readings of the violet-indigo-blue spectral range (400-475 nm), and higher readings of the upper-red spectral range (700-775nm), to the paper print. Wavelength analysis demonstrated that in general, the substrate prints decreased in indigo-violet-blue reflectance data and increased in red reflectance data in comparison to the paper prints. Wavelength analysis implied that the reflectance data in the yellow and orange range was similar except where the perceived hue was a shade of yellow or orange. This premise was not pursued further, as a decision was made to focus on visualising colour difference in a manner that appeal to designers. However, this idea remains intriguing and warrants further exploration in future research.

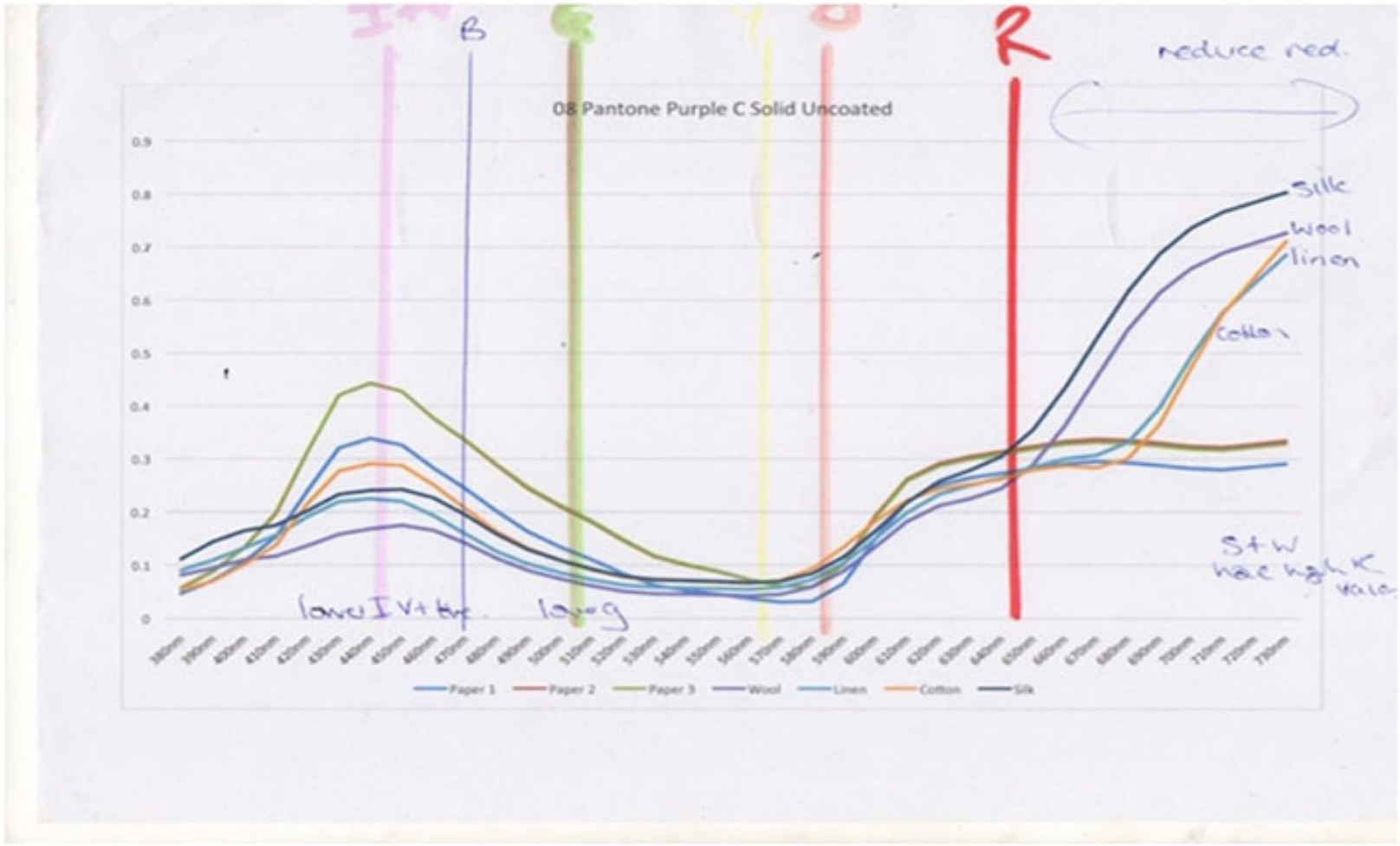


Figure 46 Gooby, B. (2017) Example wavelength line graph. Lines depict – Silk Drk Blue, Wool Purple, Linen Light Blue, Cotton Yellow, Paper Brown, Out of Gamut Adjusted Paper Blue

An example of a wavelength line graph produced using the spectrodensitometer readings. This graph is from Set One, 08 Pantone© Purple C Solid Uncoated. Comparisons were made between the path of the values returned by the paper print(s) and the fabric substrates.

4.4.2 Digital Lab Dip Tests

The LAB coordinates were entered into the colour picker tool in APCC to display a digitised version of the printed swatch, representing a digital lab dip test**.** The corresponding HSB value was recorded so that the numerical data could be more easily compared and numerical averages made. In addition, the HSB model was chosen as it is an accessible and visual representation of colour changes, in comparison to the mathematical LAB model (Schwarz, Cowan and Beatty, 1987; Henry, 2013) Finally, a colour map template was created using the HSB colour model.

Each colour map is a hue circle which has been divided into 6-degree segments. These begin at red (0°/360° degrees) and move round to yellow (60°), green (120°), cyan (180°) and blue (240°), to tones of magenta (300°). The outer ring has 100% saturation (S) and brightness (B). The rings decrease first in saturation (50% S 100% B), then brightness (100% S, 50% B), and finally both saturation and brightness (50% S 50% B). Saturation refers to the intensity of the colour. Brightness represents the lightness of the colour. A colour with 100% saturation and brightness will be very vivid but a colour with 0% will be black.

The digital swatches were plotted onto the colour map template to demonstrate the HSB shifts and to visualise how a colour might be expected to print, depending on substrate. A median value for each substrate's HSB shifts was calculated and recorded as per Table 9.

A series of colour maps was produced for both sets, with two maps per colour. Map One; showing the digital swatches in comparison with the screen-colour. Map Two; the indicator colour in comparison with the screen-colour. Figure 47 depicts an example set of colour maps for hue 01 Yellow from the first set of spectral, saturated colours. The indicator colour was derived using a median average of the value differences from screen to substrates.

Substrate	Average Hue Shift	Average Saturation Shift	Average Brightness Shift
Wool	Reduced by 4 degrees	Reduced by 18.5 %	Reduced by 29 %
Linen	Increased by 3.5 degrees	Reduced by 26.5 %	Reduced by 24 %
Cotton	Increased by 3 degrees	Reduced by 30 %	Reduced by 20 %
Silk	Reduced by 4 degrees	Reduced by 25.5 %	Reduced by 24 %

Table 9 Median Hue, Saturation and Brightness value shift by substrate

The digitised swatches appear to show a clear reduction in saturation and brightness which is expected when printing onto textured fabric, a less reflective surface to glossy printing paper and printed-colour mixing is subtractive and naturally less vibrant.

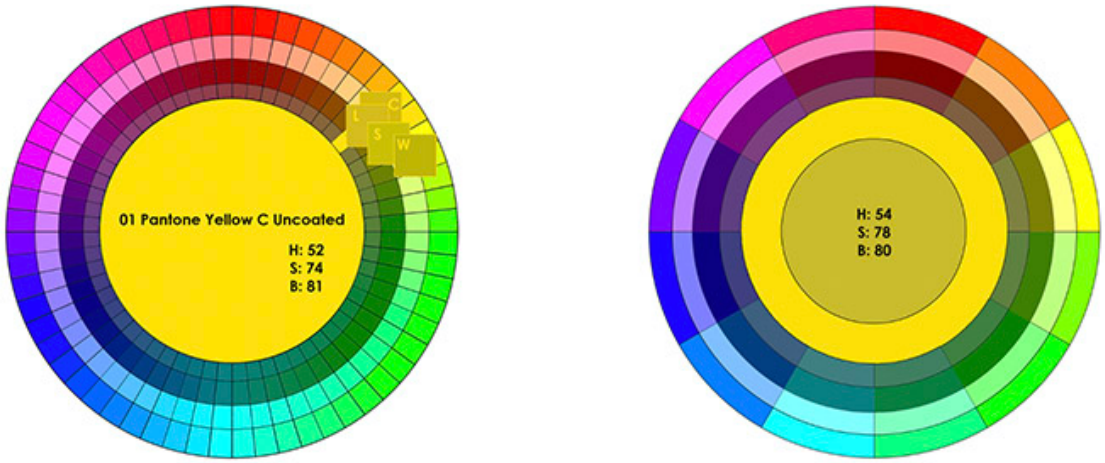


Figure 47 Gooby, B. (2017) An example of a set of digital colour maps.

Left Map One - the centre is filled by the screen-colour with its original HSB values, and the digital versions of the fabric swatches placed around the outside to indicate HSB shifts. Right Map Two – The centre and data provide an indicator colour which is encompassed by the screen-colour.

The swatches appear to illustrate some discernible differences in hue. For example, results for Pantone© Violet were on average 8 degrees bluer than the screen-colour and halved in saturation as well as decreasing in brightness. Colour measurement of the prints of Pantone© Black and Pantone© Hexachrome Black demonstrated an increase in magenta undertones. Likewise, prints of Pantone© Hexachrome Cyan shifted twenty degrees clockwise towards magenta in the hue circle. Yellow, orange, and red hues seemed less affected with minimal hue differences but there were large disparities between screen and print saturation and brightness. In contrast, Pantone© Green, and Pantone© Hexachrome Green, decreased nineteen degrees, anticlockwise, becoming yellower when printed onto fabric substrates.

A second complementary map represented an overall colour expectation shift using an average HSB value difference. These secondary maps offer an immediate idea of expected colour changes to designers by juxtaposing the screen-colour with an average, anticipated print-colour.

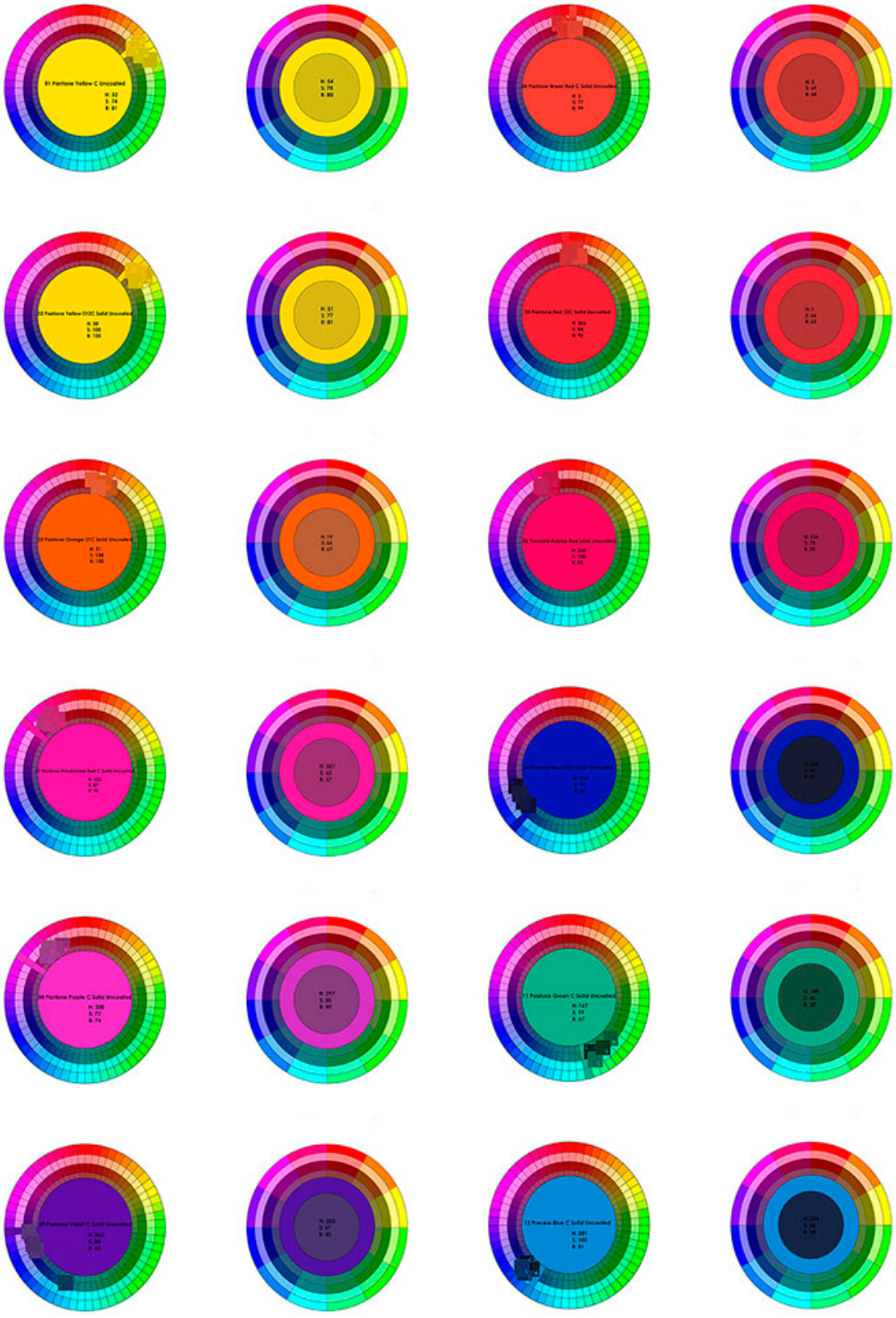


Figure 48 Gooby, B. (2017) Set One Colour Maps 1-12

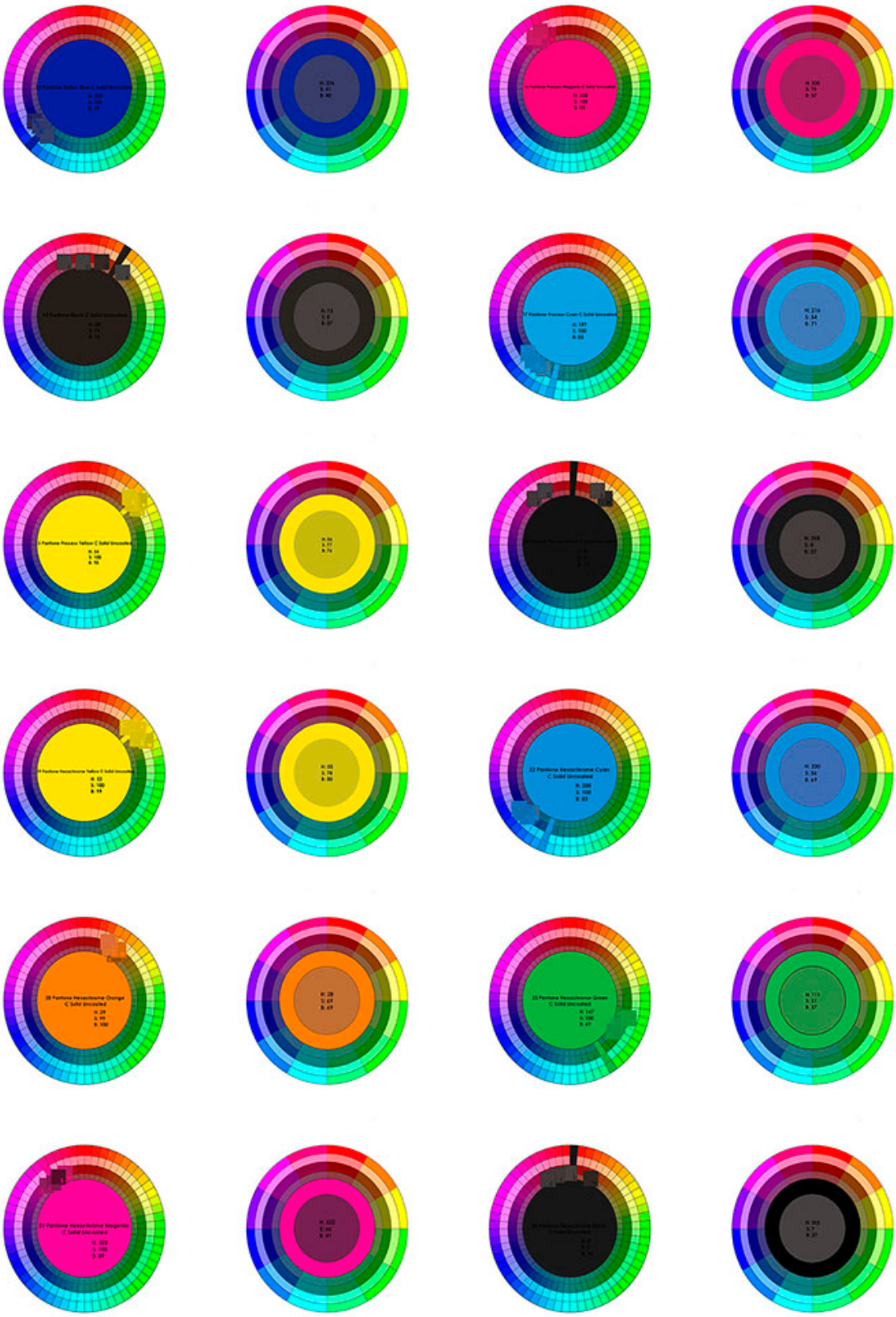


Figure 49 Gooby, B. (2017) Set One Colour Maps 13-24

Figure 50 Gooby, B. (2017) Colour Maps Set 2 1-12

Figure 51 Gooby, B. (2017) *Colour Maps Set 2 13-24*

The maps, the entire set of which are shown in Figure 48, Figure 49, Figure 50, Figure 51, appear to reveal that detailed colour testing and adjustments will be required to obtain satisfactory colour matches, particularly for prints on wool, silk and linen. Blacks, magenta tones and cooler blues and greens demonstrated the greatest hue shifts and changes to saturation and brightness, supporting the findings from the Colour Reference Book. The diagrams are a visualisation of the gamut mapping process, the recalculation of hue values from one colour space to another (Hunt, 2005).

The methods to convert colour data are known as rendering intents. Converting pixels of light on screen to printed dots of colour involves considerable modifications. A rendering intent will prioritize certain colour qualities over others, depending on the desired image outcome (Fraser, 2004). The fabric prints tested as part of this research used a perceptual rendering intent which is gamut mapping method used in by UWE's specialist technicians. Elsewhere in the textile industry absolute rendering intents are recommended unless prints contain photographic images in which case perceptual was recommended (Ding, 2016).

The colour maps and digital lab dip tests are a means of visualising the complex colour conversion process. Understanding how a colour might appear when printed onto different substrates and anticipating which colours may be more challenging to reproduce using visual prompts supports a designer's understanding of DTP and improves their digital colour knowledge.

Figure 52 and Figure 53 are photographs of expositions of the maps at the DataAche Conference, Plymouth University, 10-13 September 2017 and at the Gallery Kopio, University of Lapland, Finland from July to September 2017.

Figure 52 Gooby, B. (2017) Exhibition installation DataAche Conference Plymouth September 2017

Figure 53 Gooby, B. (2017) Exhibition installation Gallery Kopio University of Lapland Finland July to September 2017

4.4.3 Summary

The research findings from these investigations determine that the substrate has a great impact upon colour outcome. Notably, printed-colour outcome on fabric substrates appears to be darker and less vivid than screen-colour. Furthermore, printed-colour on fabric substrates will differ in hue value to screen-colour which was evidenced through colour measurement data in addition to visual observation. Importantly measuring physical

swatches and converting the data provides a method of digital lab dip testing, a means of displaying print-colour outcome, digitally, which can be used to evidence colour differences and predict colour changes. It is worth highlighting that the indicator colours in general, decreased in both saturation and brightness by 10-20% and shifted clockwise around the hue circle from 2-25 degrees in this instance. The research envisages that the lab dip test method could be used as to generate indicator colours, to predict the change from screen to print-colour when digitally printing onto a fabric substrate, and support a designer's colour expectation.

The work relates to the research questions in that it continues to examine the measures a designer might take to feel colour confident and identify mechanisms such as using digital lab dip tests as a method, which utilises theoretical concepts and production methods, to supporting improving designer's colour expectation knowledge (RQ1 and RQ2). The activity seeks to support the viewpoint that visual display methods are of value as a tool and representation of colour difference for designers seeking colour confidence.

4.5 Indicator Profiles

The inquiry considered methods for profile generation which could indicate on screen the colour alterations to expect when printing onto different textile substrates. The aim to allow a designer to detect which colour ranges may need adjusting when choosing an end substrate and arose out of preliminary profile influence experiments, p145. Profiling is a means of comparing measured reflectance data, produced by a particular device or devices, with standardised reflectance data models. Data is gathered by measuring a colour target and stored in a look up table (Green, 2010). A colour target is a set of colour swatches which range in number depending on the software used and user selection. The target is measured, and the returned data is used to provide an overview of colour options limiting the amount of data to be stored (Green, 2010; Fraser, 2004). Many screen profiles provide a false idea of colour reproduction possibilities as their gamut boundaries are far wider than the colours achievable using CMYK colourants (Fraser, 2004).

Industry experts accounts supported this premise. Emma Kendall spoke about the frustrations of not being able to see on screen how colours appear when printed, saying *"your monitor shouldn't lie"* (Appendix F p53.) and Jenny Wingfield, Studio Flock stated that a system that showed how colours were expected to appear would be particularly useful saying *"if you could see the whole thing together with how it would look rather than see individual colours… that would be really helpful"* (Appendix F p70.). Colour differences can be less obvious when viewed within an overall design rather than separate swatches. Yet a designer, who is used to gauging colour changes and would know when colours were *off*, could utilise this method to detect which colour ranges may need adjusting, prompting colour resolution practice at the design stage, prior to hard proofing, saving time and reducing costs.

A breakdown of the objectives for this research activity would be 1) Establish a method to edit or alter ICC profiles so that the colour data could be modified, 2) Create a number of profiles based on data gathered by measuring the Colour Reference Book, and 3) Gain an understanding of Colour Management Processes, in particular Colour Look Up Tables and Colour Data Conversion.

An analysis of profile creation software was conducted to determine whether it was possible to edit profiles as well as generate them. However initial investigations established that extensive knowledge of programming would be required. Consequently, a more creative option was taken. The colour targets were directly altered to modify the information returned to the profile maker software.

To create the indicator profiles, a colour target consisting of 1748 swatches used by Printer Cal - profile maker software for AVACADCAM, was modified in APCC. AVACADCAM is a specialist software for textile and decorative surface designers and producers (AVACADCAM, 2020). The modifications were made using the numerical median average data as per Table 9 for each of the four substrates, to adjust the HSB settings. The targets were printed onto cotton satin and measured with an Xrite i1 Profiler Spectrophotometer under D65 lighting conditions. Figure 54, Figure 55, Figure 56, Figure 57, Figure 58 show the resulting targets and the original as a comparison. Like with previous colour measuring exercises the colour data was not always reliable and so close examination was made of the measured colour when it appeared on screen in the profiling software, AVA Printer Cal. Unlike paper printed colour targets which can be measured in lines of colour chips, textile printed colour targets have to be measured as individual colour chips which is time consuming.

The resulting ICC Profiles were assigned to the specifically created colour test collage image in APCC, used in preliminary experiments, to observe the colour changes on screen as shown in Figure 59, and observations recorded in Table 10. Further images of the applied profiles are shown in comparison with the virtual device ICC profiles in Figure 60. Profiles were further compared using Apple's ColourSync Utility with two standard generic ICC profiles, Adobe RGB (1998) and sRGB IEC61966-2.1 in Figure 61. All indicator profiles appeared to demonstrate a loss of brightness and saturation in comparison with the standard, generic profiles which was in keeping with the reduced brightness and saturation appearance of printed textiles, and subtractive colour.

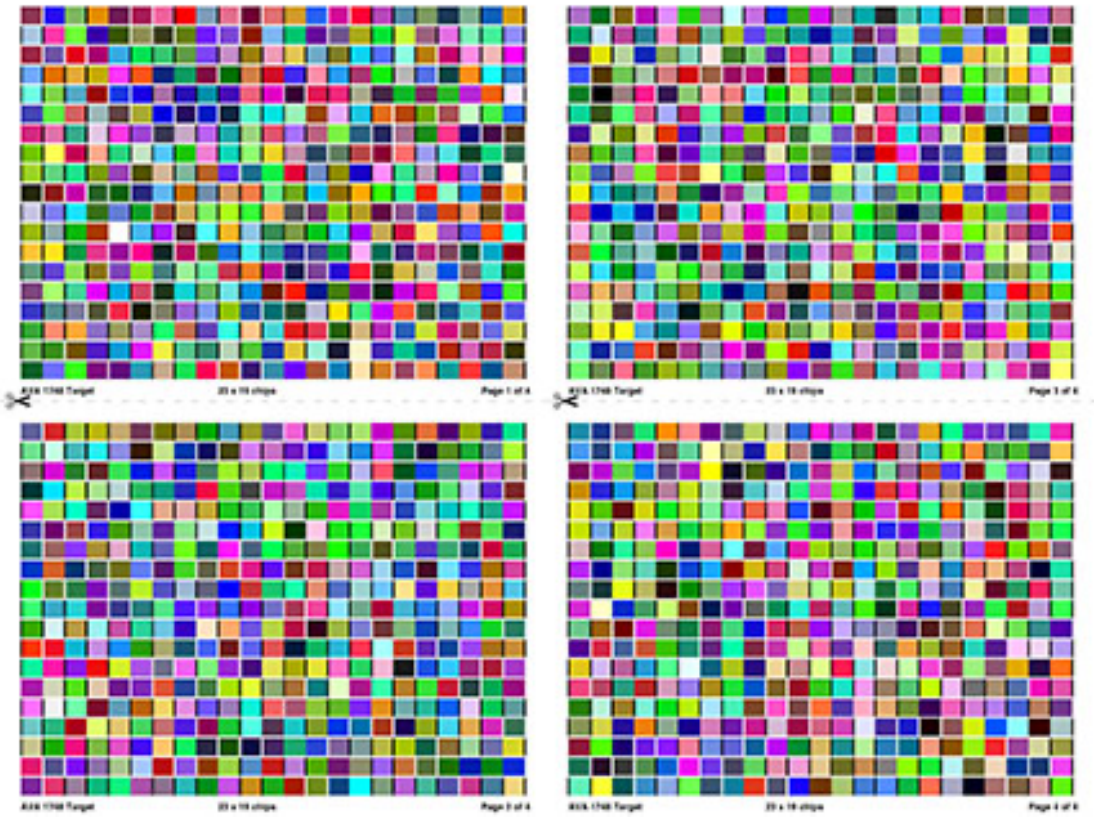


Figure 54 Gooby, B (2018) Original AVA 1748 RGB Colour Target

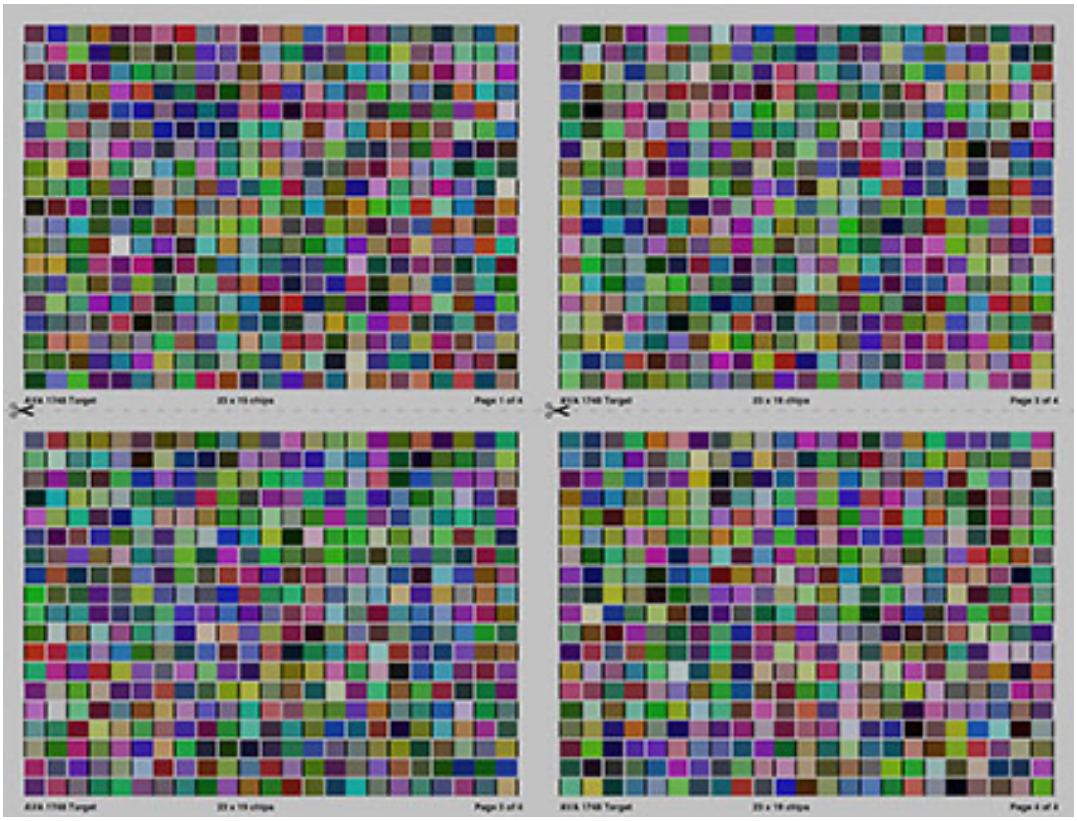


Figure 55 Gooby, B (2018) Altered Colour Target for Cotton Hue increased 3 Degrees, Saturation reduced 30% and Brightness reduced 20%

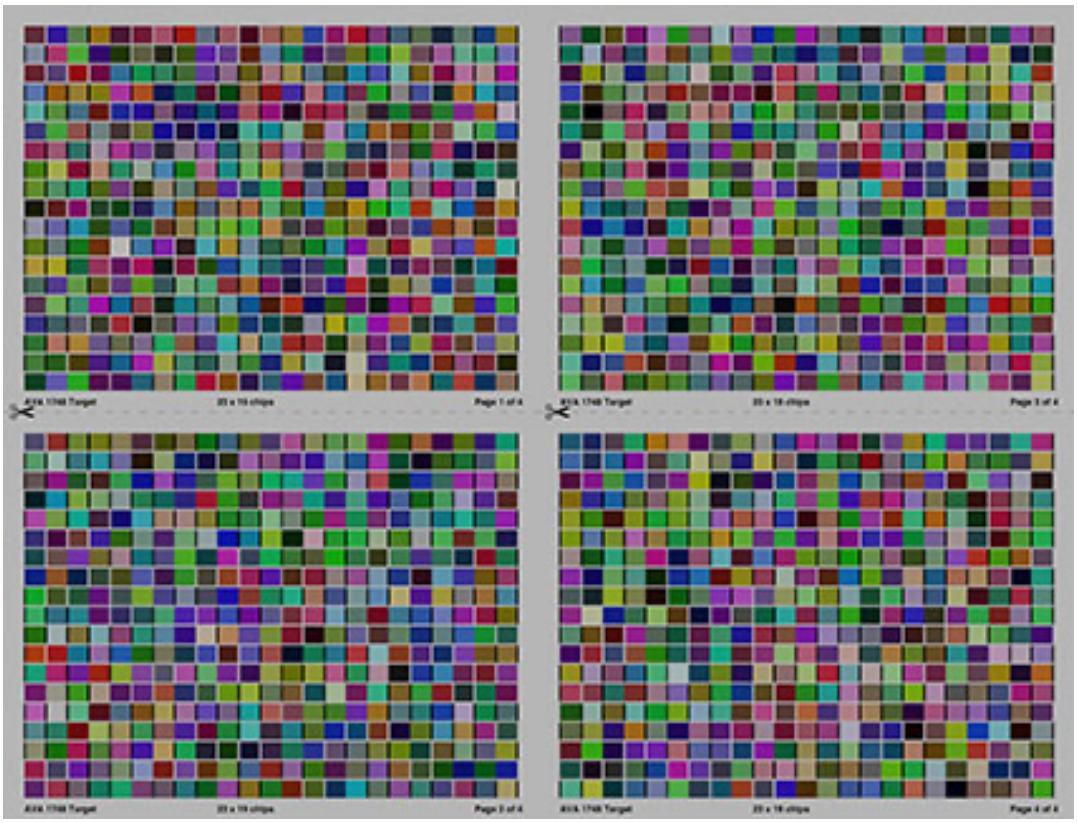


Figure 56 Gooby. B (2018) Altered Colour Target for Silk Hue reduced by 4 Degrees, Saturation reduced by 25.5%, Brightness reduced by 24%

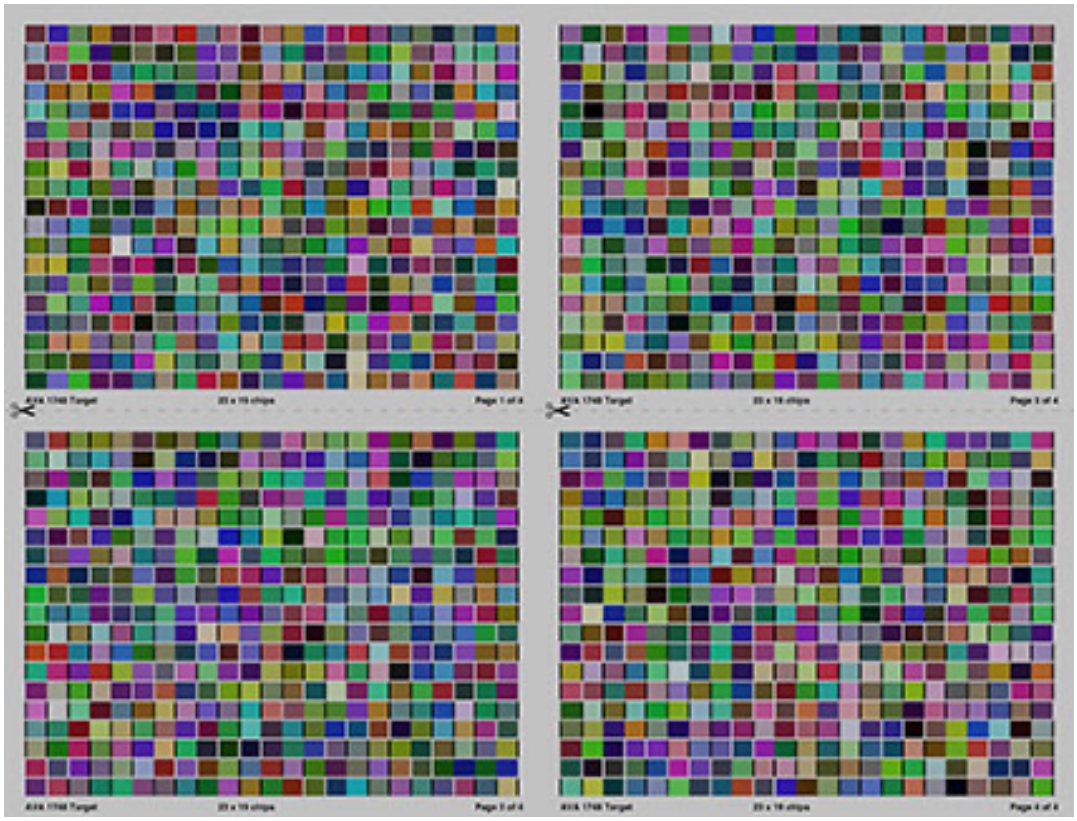


Figure 57 Gooby, B (2018) Altered Colour Target for Linen Hue increased 3.5 Degrees, Saturation reduced 26.5%, Brightness reduced 24%

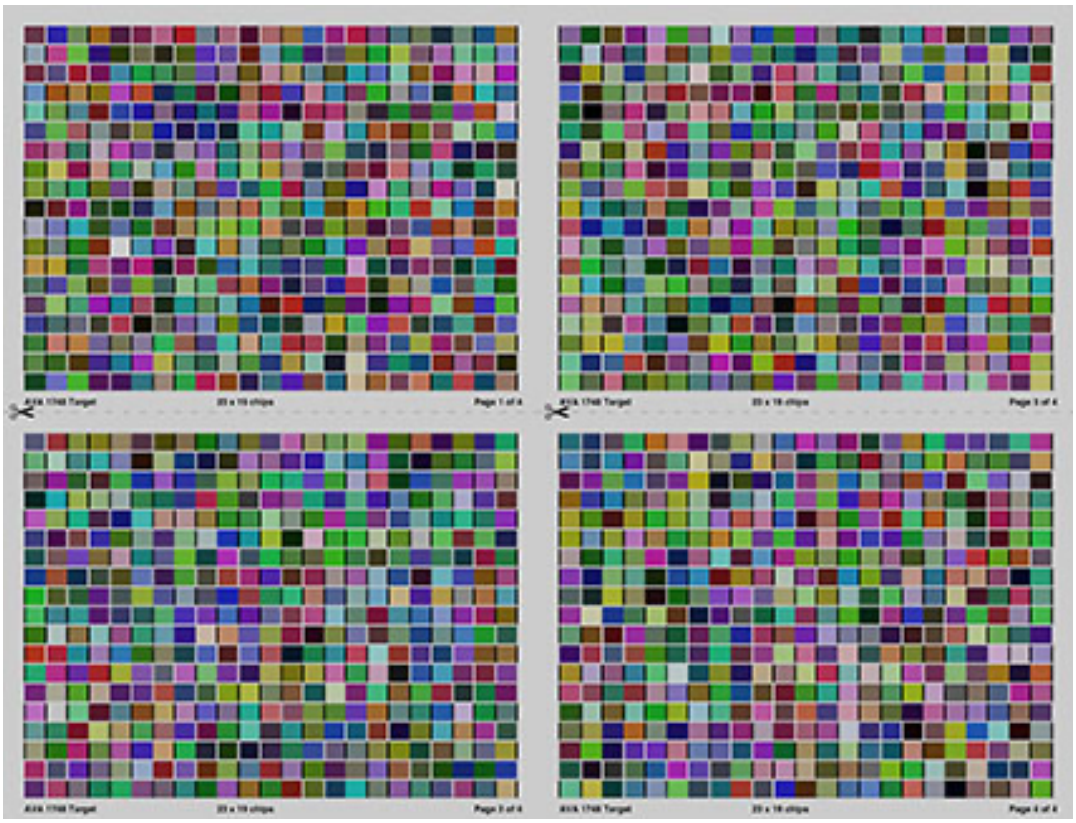


Figure 58 Gooby, B (2018) Altered Colour Target for Wool Hue Reduced by 4 Degrees, Saturation reduced by 18.5%, Brightness reduced by 29%

Indicator profiles developed to demonstrate colour differences by substrate

Figure 59 Gooby, B. (2018) Colour Collages with assigned profiles.

Top row L-R Wool, Linen, Silk Bottom Row L-R Cotton, sRGB IEC61966-2.1. Adobe RGB 1998

4.5.1 Observational comments

Profile	Observation
Wool	The image had a slightly orange appearance which was most noticeable in the neutral colour ranges. The colours appeared muted in comparison with the images assigned with sRGB IEC61966-2.1 and Adobe RGB 1998 profiles. Colours from the blue / magenta tonal ranges were most vivid and green tones appeared bluer. The neutral ranges had a soft contrast and appeared to have a sepia-like appearance.
Linen	The image had a slightly yellower appearance which was most noticeable in the neutral colour ranges and in the red tones. Blue and green tonal ranges appeared yellower. Neutral tones had a strong contrast but instead there was a loss of tone quality.
Silk	The image had a slightly magenta appearance which was most noticeable in the neutral colour ranges. The red tonal ranges appeared strong and spectral colours were saturated. Neutral ranges appeared darker than the linen or wool images, with a strong contrast.
Cotton	The image had a slightly orange-red appearance. The neutral ranges did not appear influenced by this tint. The colours were strong and saturated - similar to the silk profile, except that there was improved tonal quality and decreased contrast which achieved a better colour balance.
sRGB IEC61966-2.1	The image had strong saturated colours in comparison to the indicator profiles with no apparent overall colour tint. The neutral ranges had a slight green quality to them, but contrast, tonal quality and colour balance were all good.
Adobe RGB 1998	The image had incredibly strong saturated colours, particularly in the blue tonal ranges, in comparison to the indicator profiles with no apparent overall colour tint. There was strong contrast but a lack of tonal quality. The neutral ranges had no apparent colour tint.

Table 10 Visual analysis of indicator profiles when applied to the Colour Collage

Figure 60 Gooby. B (2018) Enlarged visual comparisons of each indicator profiles with virtual device comparisons

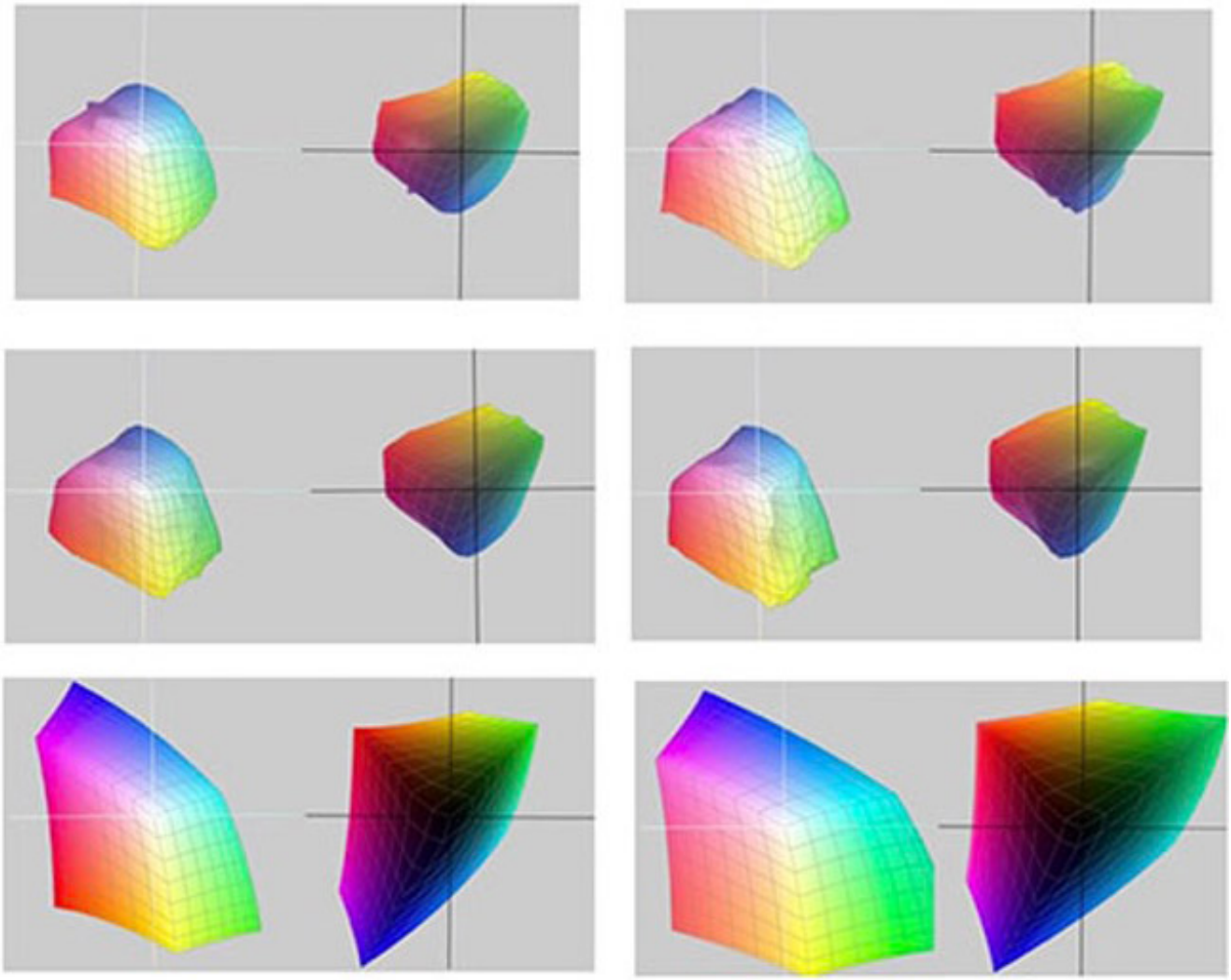


Figure 61 Gooby, B. (2018) Apple ColorSync visual representation of each indicator profile gamut and virtual device profile comparisons showing the white and black point of each space

Top row L-R Wool, Linen, Middle row L-R Silk, Cotton Bottom row L-R sRGB IEC61966-2.1, Adobe RGB 1998

Comparisons in Apple's ColourSync Utility showed that the gamut of the four indicator profiles was considerably smaller than the standard, generic profiles as visualised in Figure 61. The Wool indicator profile had the smallest achievable gamut and Linen the largest. The Linen indicator profile extended to the palest of shades whereas the Silk indicator profile achieved the darkest colour ranges of the four.

To mitigate subjective bias and the positionality of the researcher reflexivity (visual observations and audio reflection) and external critique was incorporated.

4.5.2 Summary

The resulting substrate profiles seek to offer a visual indication on screen to designers of the overall colour shifts that may occur when printing onto different substrates. The aim to improve designer's colour knowledge and prompt colour resolution practice at the design stage. The results are subtle and not as stark as some of the colour differences in the Colour Reference Book, one presumes, because colour differences are more challenging to identify when viewed within an overall design as opposed to separate swatches. Notably, altering colour targets can provide a method to produce changes to the colours seen on screen. Therefore, the substrate Indicator Profiles have the potential to be used as part of a proofing exercise to get a sense of colour differences determined by substrate. It should be emphasised, however, that further testing would be required with users to determine the effectiveness of this method.

The work relates to the research questions in that the findings of the activity continue examine measures (RQ1), here an indicator substrate profile, to improve colour expectation. Furthermore, this method visualises colour data conversion, impact of textile materials and chemistry in the printing process (RQ2) so that designers, as *colour determiners,* can make corrections to their design work prior to print.

4.6 British Interwar Case Study

This Case Study observed colour use during the British Interwar period to create a body of work as a real-world test case for the modality of visual colour methods. In addition, the study looked at the economic, societal, cultural, and technological changes that impacted upon textile design - in particular new printing technology, fabrics, and dyes during this era, as comparative analysis to determine the responses to change and answer the questions around Colour archive, RQ3 *How can historical colour use inform colour aesthetics in digital print on cloth? a*nd RQ4 *How did colour use develop in the British interwar period?* Supporting material can be found in Appendix G.

The rationale for considering a Colour Archive theme, in addition to providing a test case for the modality of visual colour methods, was that firstly textile design frequently draws upon past trends and fashions, using nostalgia for inspiration (Guffey, 2006) and in seeking to present research insights to the desired audience, familiar techniques would be useful tools for communication and acceptance. The practice of using varied sources for colour inspiration was touched upon in the Colour Conversations. In describing her design process Jacquline Milton said that she starts her designs by making written notes and collecting ideas and colours together (Appendix F p84.) and Liz Moss from Made in Brighton said, *"our colour choices are based on our designer's eye"* (Appendix F p89.). Secondly the era featured a similar change in technology and increased access to colour, which required designers to adapt their aesthetics and working methods. This drew comparisons with the emerging technology of DTP and designing with access to 16.77 million colours on screen.

Rather than being tagged onto the end of the inquiry, this case study was begun in the early stages and ran in conjunction with improving Colour Expectation. Thus, parallels began to develop in that some of colours encountered from the archival research proved problematic to print, for example Hunter's purples and magentas, the moquette dark greens and sludgy neutrals, and Crysede's bright blues as per the findings of the Colour Reference Book.

The knowledge gained of designers' responses to new technology and materials was also absorbed. Eileen Hunter and Enid Marx especially highlighted similarities between their

experiences of working with new innovations as the industry experts reported in the Colour Conversation series. For example, Designer Consultant A described the DTP as a technology that she loved and needed "*as a designer and an artist"* (Appendix F p38.), but that it was "*like a blend of the adventures of getting things wrong"* (Appendix F p38.) and Jacquline Milton noted that whilst digital print is not a perfect means of printing textiles, it had opened doors for her to set up her own business and have more control over production. Similarly Hunter described working in textile design in the 1930s as an *'adventure in design'* (Hunter, 1979) due to the creative atmosphere and freedom from the opening up of new ways of manufacturing. Marx recalled the difficulties in establishing the correct proportions for her designs with the manufacturers whose machinery could only weave oblong sections rather than her preferred squares (Marx, 1980). She also talks about how exciting and enlightening working in the Interwar period was describing it as a time of '*extraordinary flowering of the arts'* (Marx, 1980). These made compelling comparisons.

The objectives of the activity are outline as 1) Identify and visit a number of textile archives from the British Interwar period, 2) Create a colour palette which represents colours from this era, 3) Consider the impact of technological changes (introduction of silk screen printing and new chemical colourants) in the Interwar era on textile design, 4) Gain an understanding of the colour use and textile design trends during this period, 5) Produce a body of colour work for testing using the identified colour palette, 6) Test methods from research inquiry using the resulting practice, 7) Document and evaluate the results, and 8) Create a number of colour palettes to be downloaded as test palettes for the Project Tool-kit.

The outputs of the research activity are as follows 1) 4 Colour palettes – digital ASE files, 2) A set of colour studies and sketchbooks, 3) 11 textile designs in over 144 colourways, 4) 2 annotated sample books containing the Interwar designs, and 5) An Excel spreadsheet detailing analysis.

4.6.1 Ushering in technological change

A historical literature survey on the colour palette in the British Interwar was undertaken to meet Objective 5. This established that several factors collectively influenced colour trends and development in Britain during this time. The period after the First World War saw huge economical and societal changes. A house building boom and the introduction of mortgage loans made homeownership and therefore interior decoration available to more of the British population (Cohen, 2006). The middle classes were on the rise with money to spend on furnishings and ready-to-wear clothes in the new department stores (Cohen, 2006). Newly introduced commercial CMYK paper printing reduced the cost of colour prints. This allowed the public to see accurate, colour images in new home decoration and fashion journals, influencing taste and style (Cohen, 2006). The first colour forecasting and trend agencies were set up to inform manufacturers on consumer tastes (Cassidy, 2005). A British look emerged, a more colourful version of continental modernist trends. Organisations such as the Design and Industries Association and the British Colour Council (Barman, 1979; Osborne, 2017) sought to champion *good* design standards in partnership with industry innovation, a modern follow on from the British Arts and Crafts movement (Saler, 1999). These '*medieval modernists'* (Sadler, 1999) led a shift towards the '*marvellous machine*' (Thomas, 1979) as well as responding to a need for standardisation as the result of the swift introduction of new technology.

Protectionist economics saw sales increases of British textiles (Bury, 1980) . Warner and Son took the opportunity to grow their fabric printing business through the incorporation of a screen print workshop, a new printing technology for textiles - producing their first silk screen print *Shrubbery* by V Muller in 1931 (Boydell, 1995). A surplus of unmarried women, turned to work with textiles and interior decoration: considered to be suitable jobs for women (Boydell, 1995). Artists became designers to generate income during a time of economic instability, with Allan Walton Textiles, Edinburgh Weavers, and Omega Workshop championing artist-led design. The employment of freelancers; predominantly women, gave manufacturers the opportunity to test out modern designs, without having to provide financial commitment (Boydell, 1995).

In 1931 the International Commission on Illumination, established in 1913, defined the CIE XYZ colour space, a revolutionary mathematical model of the visible spectrum. Le Corbusier created his colour harmony selections, *colour keyboards*, to provide advice on colour harmony. The principles and rules of colour had never been more widely studied or available (Patmore, 1933)

Reviewing Fashion and Textile archives for colour inspiration

Archival research is selective in its very nature (Barrett and Bolt, 2014). Items will have been kept and stored because they were valued at the time or have been collected because of a belief that they are valuable or able fulfil a particular narrative. An initial survey of research on the British Interwar period established several key archives to visit, based on their content (colour ranges) and accessibility (geographic location[64], expenses to visit) including the Victoria and Albert Museum (V&A) archive at Blythe House and Transport for London's Acton Depot, which holds the moquette seating collection. Further research uncovered Eileen Hunter, a freelance textile designer working in the 1930s with Warner and Son whose archive is held by the V&A. A visit was made to the Crysede collection in Cornwall which was recommended as a unique insight into how bright colours were used in high fashion during this time. Finally, the inquiry examined the work of the Bloomsbury Group's *Omega Workshop*, and society decorators Colefax and Fowler. Archive visits were made both in-person and digitally. Photographs and sketches acted as documentation and a reflective journal was produced after the visit.

4.6.2 Crysede Archive, Penlee Museum 4th April 2016

Crysede produced high end fashion pieces during the 1920s introducing modernism from the '*Cornish Colonies'* (Sinclair, 2009 p14.). It was set up by Alec Walker and his wife Kathleen Earle. Crysede produced colourful block printed fabrics for couture dresses and scarves. The dyes were British synthetics - bright and colourfast. This archive was recommended as an exemplary example of saturated colour use in the Interwar period, for high end fashions, with a compelling narrative around the use of novel modes of industry and cross overs between art and design, to tell the story of response to new chemical

colours in textile design, particularly focusing on colour categorisation – colour charts and design colourways.

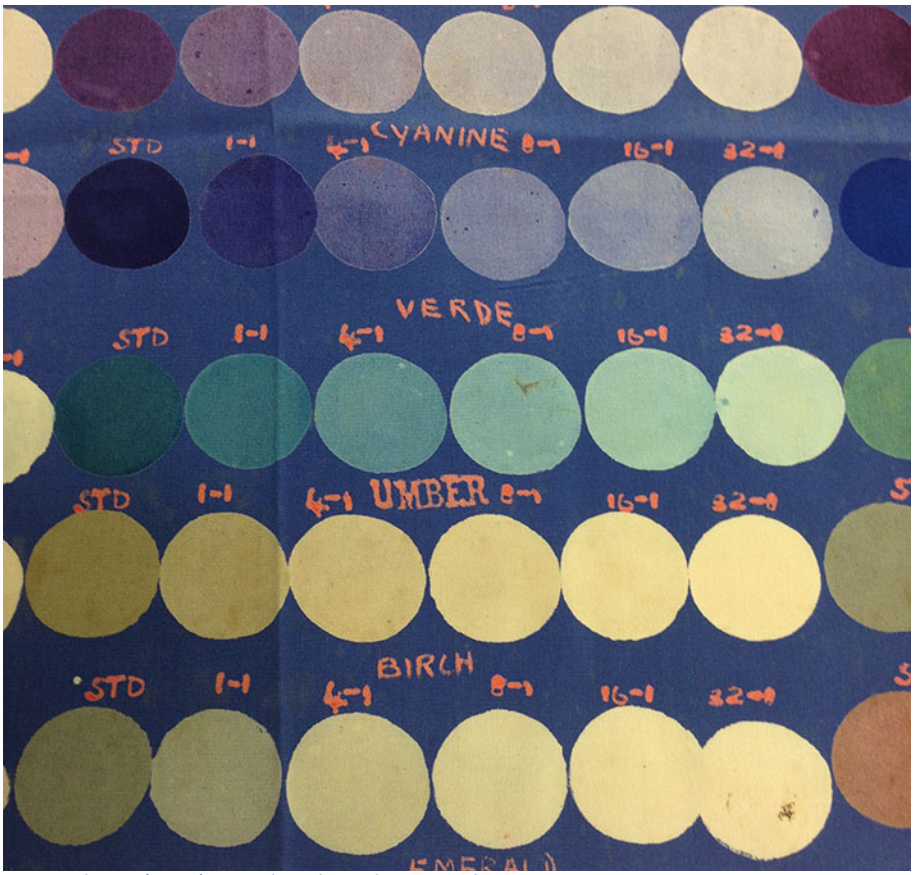


Figure 62 Gooby, B. (2016) Crysede Colour Chart Detail

At the visit fabric swatches were viewed, an image of which is shown in Figure 63, alongside several colour charts, as shown in Figure 62, with rows of coloured circles starting with the standard dye colour and then lighter mixes with notes on the proportions. Some of the colour names are evocative of the moderne era, for example *Tango, New Flame, Picasso.* It also holds a selection of garments as well as the digital archive of the entire collection including several dresses, scarves, and fabric lengths. There are also a few odd items such as curtains, tea cosies and aprons, believed to have been made by staff members from fabric off-cuts. In addition, an ongoing dialogue was had with Jeanie Sinclair; a researcher documenting the work of Crysede and the art and design aesthetics which emerged from Cornwall in the 1920s and 30s. The visit was documented on the reflective blog[65].

The Crysede collection is a good example of the new synthetic colours available to textile designers. It is important to acknowledge that these textiles were for high-end fashion use and would not have been typical of everyday dress fabrics. The archive provided an excellent example of a rigorous colour sampling system. The fabrics were natural fibres (cotton and silk), and the printing method was block printing. Whilst high end fabrics, the colours and designs would have had an influence upon wider fashion trends as they'd have been worn by high society women who would have been photographed and written about in magazines and journals.

Figure 63 Gooby, B. (2016) Page from Sample book at the Crysede Collection

A set of colour studies were made based on photographs and sketches made at the visit which are shown in Figure 64. These were used to create a Crysede Colour Palette - rich with strong, earth colours and bright hues. An illustrative design, inspired by the Bristol

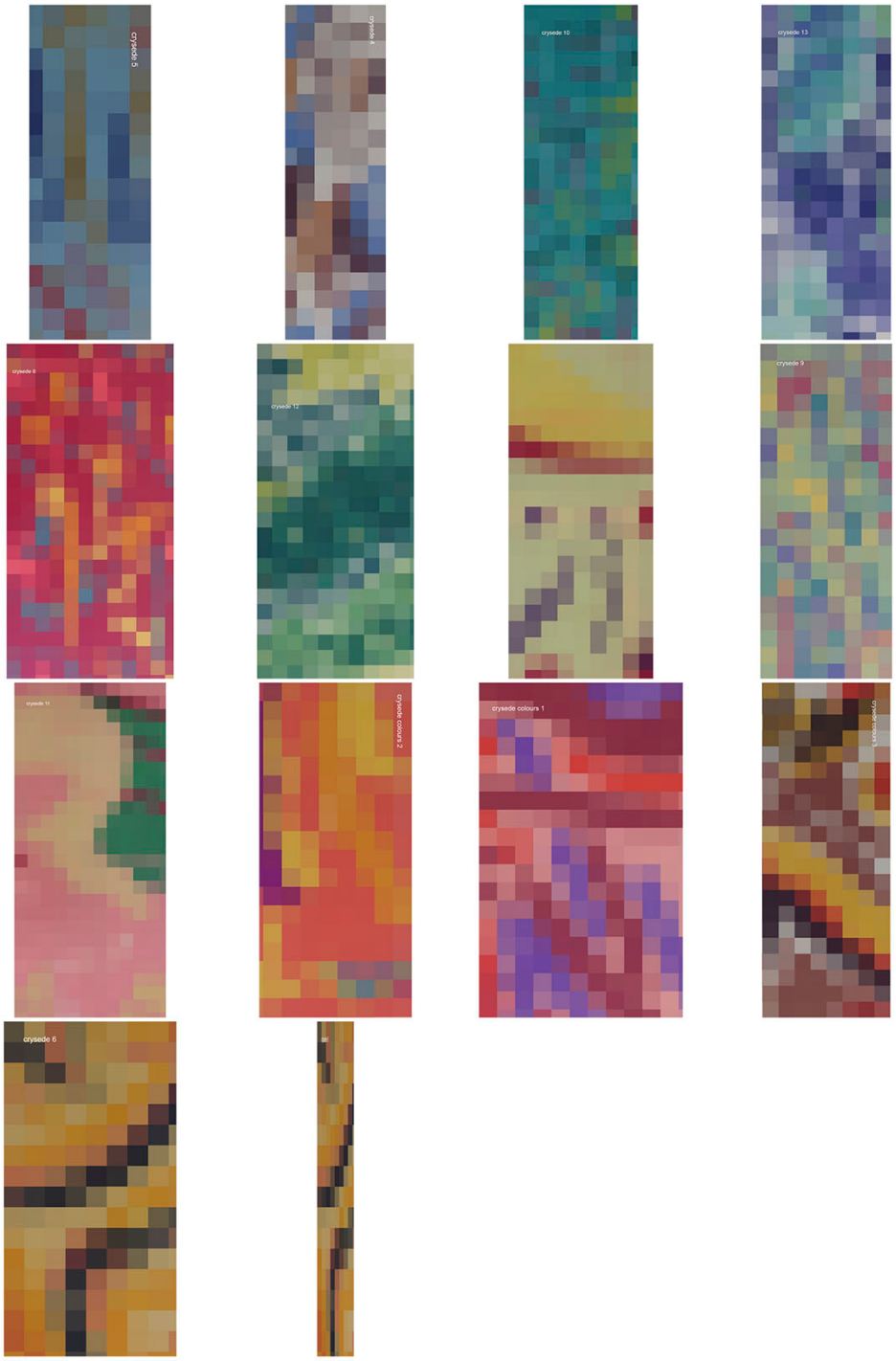


Figure 64 Gooby, B (2017) Digital sketches of fabrics from the Crysede Collection

landscape, to emulate how Walker and Earle's designs were inspired by their Cornish surrounds including the sea, These were generated in several colour ways using the Crysede colour palette, as shown in Figure 65, and Figure 66 provides an example of two of these.

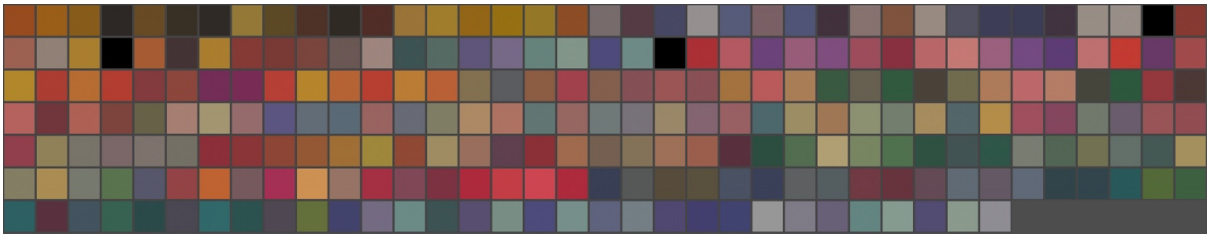


Figure 65 Gooby, B (2020) Crysede Colour Palette derived from historical archival research

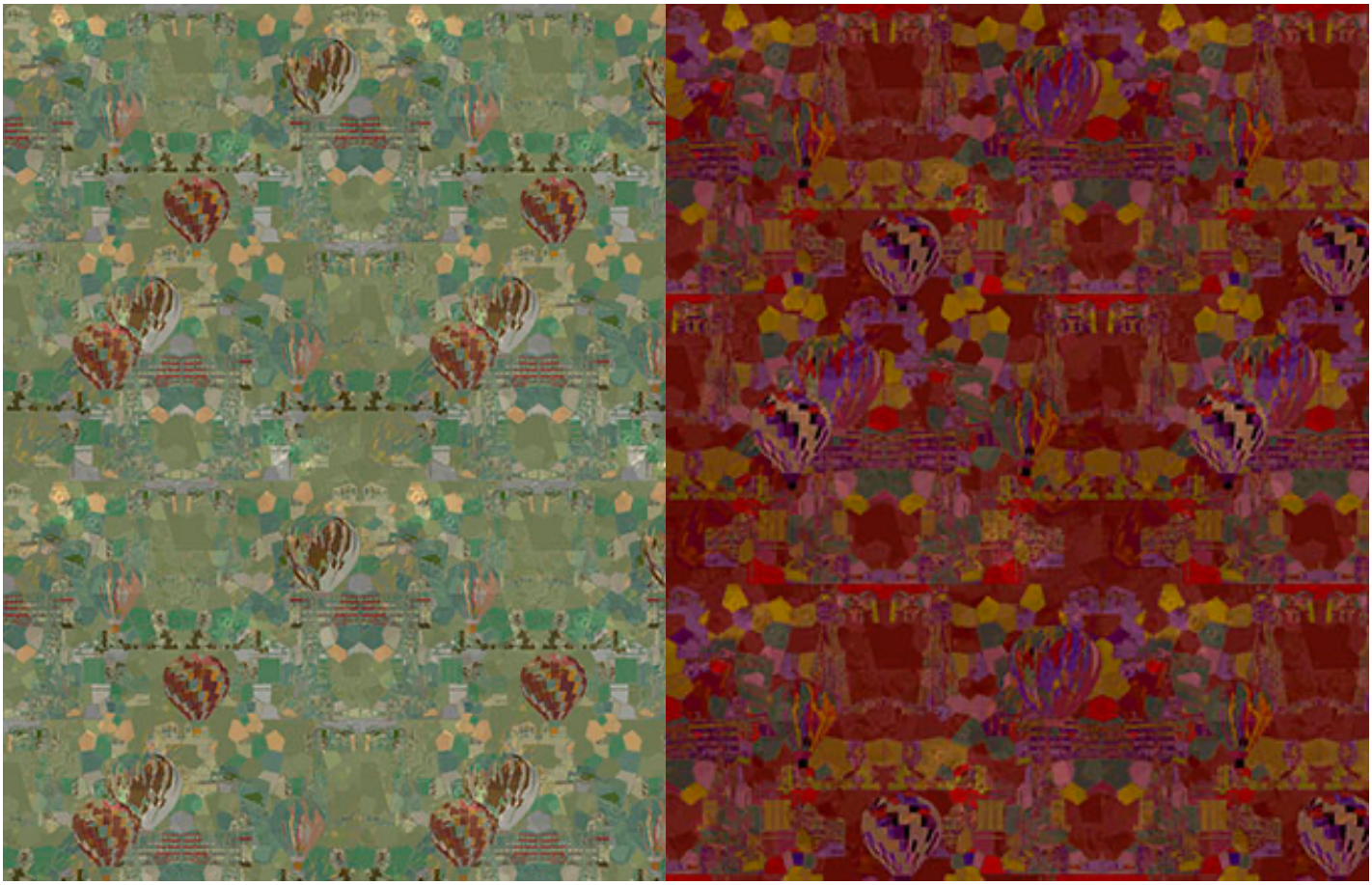


Figure 66 Gooby, B (2020) Two Colour Ways from the Crysede Inspired Design

4.6.3 Visit to Transport for London Acton Depot to see moquette fabrics designed by Enid Marx and Marion Dorn 31st October 2017

The Managing Director of London Transport in the 1920s was Frank Pick. He founded the Design and Industries Association and subsequently the Council of Art and Industry in 1934 set up to develop guidance and standardisation in relation to mechanisation, new technology and new materials. Pick commissioned much of the now iconic branding for the tube. Dissatisfaction with stock moquette prompted Pick to employ prominent designers to

create bespoke designs (Barman, 1979; Saler, 2008). The rationale for visiting this archive came out familiarity of moquette fabrics from the researcher's professional practice[66], and the story of Enid Marx, who pioneered responses to technological change and mass manufacturing in textile design, and thus a significant and noteworthy subject to examine or explore further.

Moquette is a durable tufted woven fabric used to upholster transport seating. It must hide stains and dirt and the patterns need to avoid a visual dazzling affect. The colour palette was the London Transport's house style. Branding, a new concept, was part of Pick's desire to create a recognisable and trusted look across London transport to entice passengers and make them feel safe and comfortable (Saler, 2008).

The designers: Marion Dorn and Enid Marx were already established in their field. Dorn's designs would become synonymous with the moderne look. One of her carpet designs can be seen at Coleton Fishacre, an Art Deco house in Devon; the circular and grid design similar to the Canonbury pattern she designed for Pick. Marx was selected to design for the Board of Trade Utility Furniture during the Second World War creating textile designs for furniture and interiors.

A number of moquette samples were viewed 1) Ladder by Marion Dorn 1936-7 (various colourways), 2) Caledonian by Marion Dorn 1938, 3) Canonbury by Marion Dorn 1937, 4) Leaf by Marino Dorn 1938-9 (various colourways), 5) Brent by Enid Marx 1936-7 (various colourways) – depicted in Figure 67, 6) Belsize by Enid Marx 1940, and 7) Bushey by Enid Marx 1936. The visit was documented on the inquiry's reflective blog[67].

Figure 67 Gooby, B. (2017) Moquette sample of Marx's Brent design at TFL Archive

The designs were primarily dark colours with accents of bright red and light green. Many of the designs were tonal using dark and mid-tone colours such as green, pink, brown or blue alongside an accent colour. The designs featured 3-4 colours and incorporated additional texture and tone using boucle loops, where parts of the pile are left uncut. It was not possible to determine what dyes had been used. The motifs were predominantly geometric with only Dorn's *Leaf* design incorporating a natural element. It must be presumed that there will have been some colour fading due to the age of the fabric samples.

A set of colour studies were produced using photographs and sketches made during the visit which provided a range to produce a colour palette. The palette, Figure 68, consists of strong, dark, earth colours - forest green, sage green, dusky pink and chocolate brown and accent highlights of red and sky and navy blues. Several geometric designs were created and produced in several colourways using the colour palette, examples are shown in Figure 69.

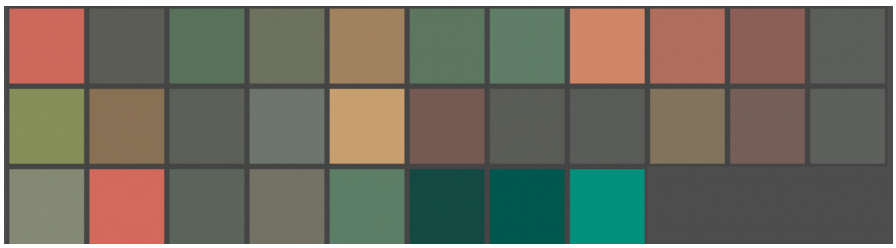


Figure 68 Gooby, B (2017) Transport for London Colour Palette derived from historical archival research

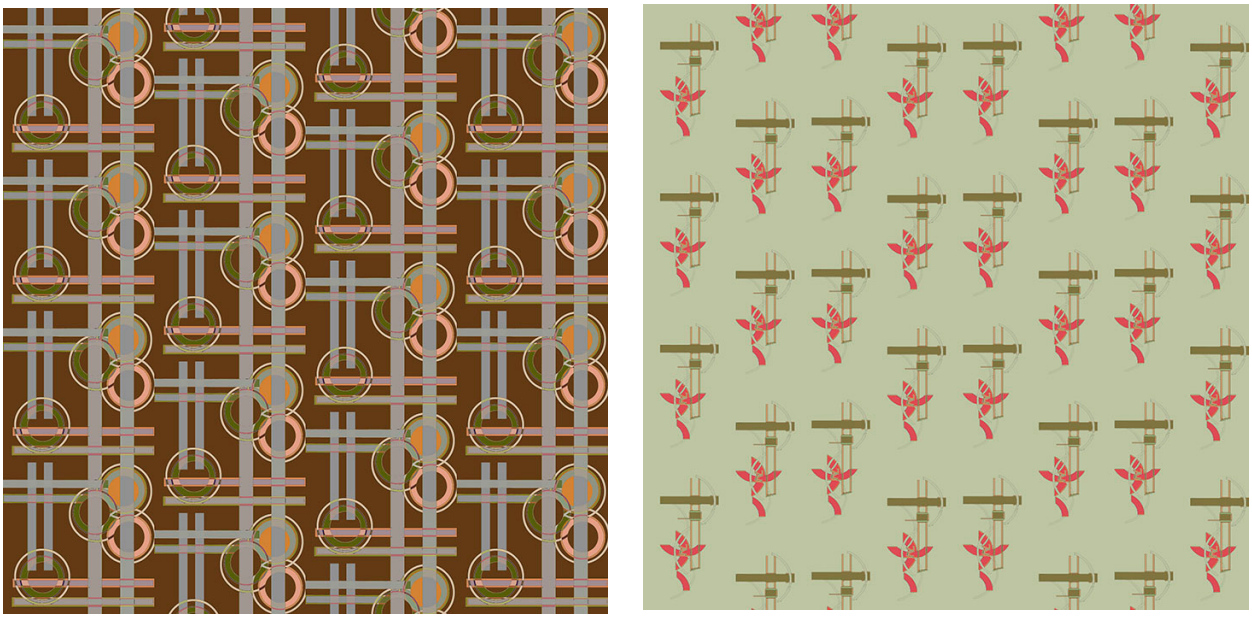


Figure 69 Gooby, B (2020) Two of the designs inspired by Transport for London Moquettes

4.6.4 Visit to The Clothworkers Centre for the Study and Conservation of Textiles and Fashion at the V&A Archive to view textiles by Eileen Hunter 26th January 2018

The Clothworkers Centre houses the Eileen Hunter Archive. Hunter was a freelance textile designer in the 1930s designing for soft furnishings and interiors. The rationale for viewing the work of Eileen Hunter arose out of encountering a reference to her in an article written by Boydell (1995) about the rise of freelancer textile designers in the 1930s, a change in commercial structure from in-house design studios, similar to how textile designers are currently having to be more entrepreneurial (Ujiie 2006). Hunter's story was particularly compelling because she'd written her own autobiography detailing her experience as a

textile designer and also lectured about her experience to audiences in 1970s (Hunter, 1979). Furthermore, Hunter pioneered the use of new colours, colour schemes and metallic colours as well as trialling the new print method of silk screen printing.

Some of the designs had names such as *Apollo* and *Cornucopia* but most had a numerical reference. An example of her work is shown in Figure 70. Hunter's fabrics were printed by Warner and Son - some using the new silk screen printing technique. The visit was written up on the reflective blog[68].

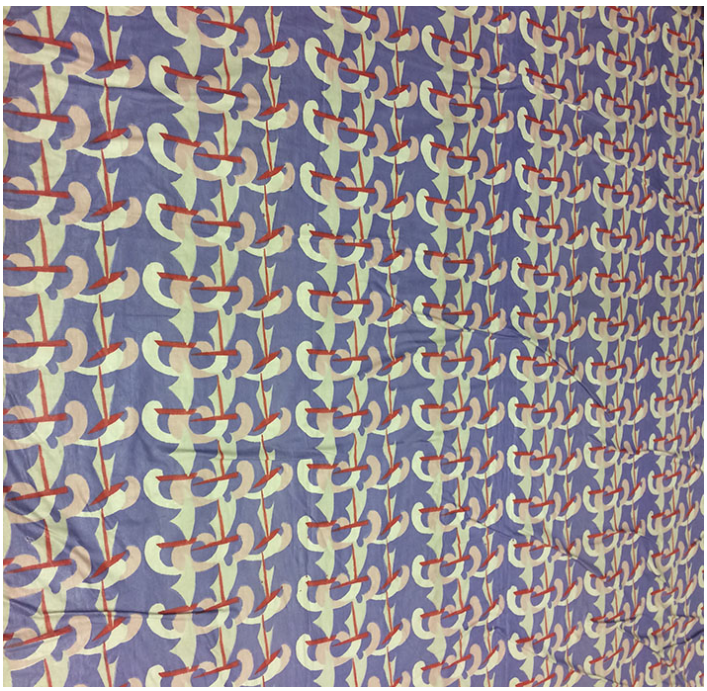


Figure 70 Gooby, B. (2017) Eileen Hunter fabric laid out at Clothworkers Collection

Hunter's colours were bold using strong emerald-green, tonal pinks, marine blue, and purples. They are unusual because strong colours are atypical of furnishing fabrics. Hunter was frequently commissioned to design for hotels and exhibitions as well as bespoke interiors for the upper classes (Hunter, 1969). Therefore, it must be presumed that these colours were not frequently seen in a typical domestic interior.

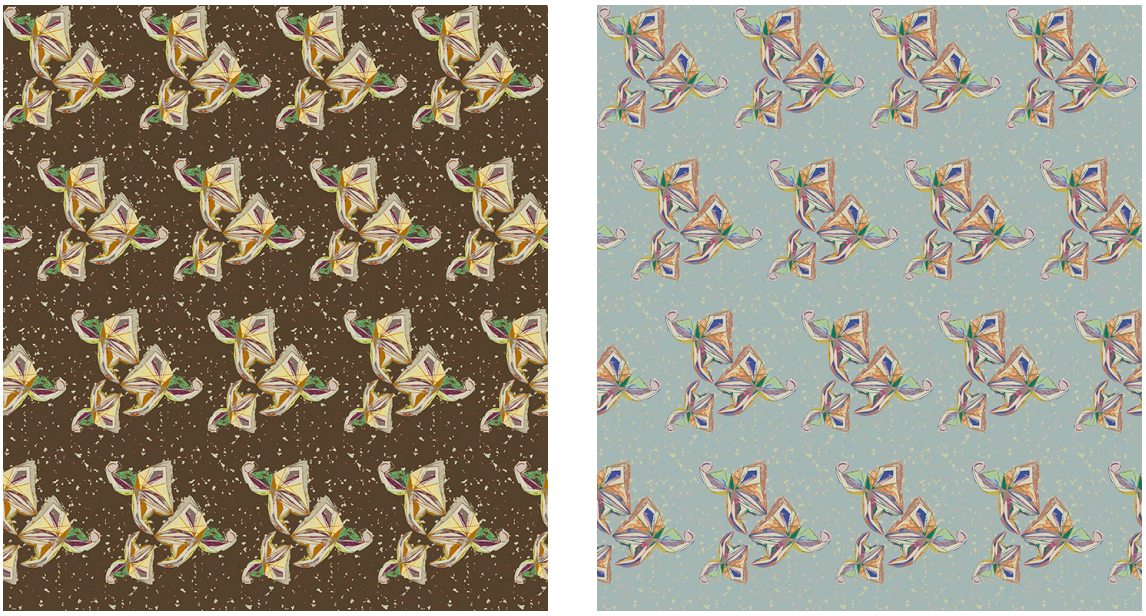


Figure 71 Gooby, B (2020) Two of the designs inspired by the visiting the Hunter collection

A set of designs were drawn up, inspired by Hunter's illustrative style. They were printed in several colourways using two colour palettes generated Pantone© references grouped to document colours used 1910s, 1920s, 1930s and 1940s (Eiseman, Recker and Pantone, 2011), 1930s palette shown in Figure 73, and colour measuring Interwar paint charts (Baty, 2017), as shown in Figure 72.

4.6.5 Further material

In addition to the archive visits, the inquiry sought to examine material related to the Interwar period through visits to exhibitions and by reviewing primary and secondary textual sources.

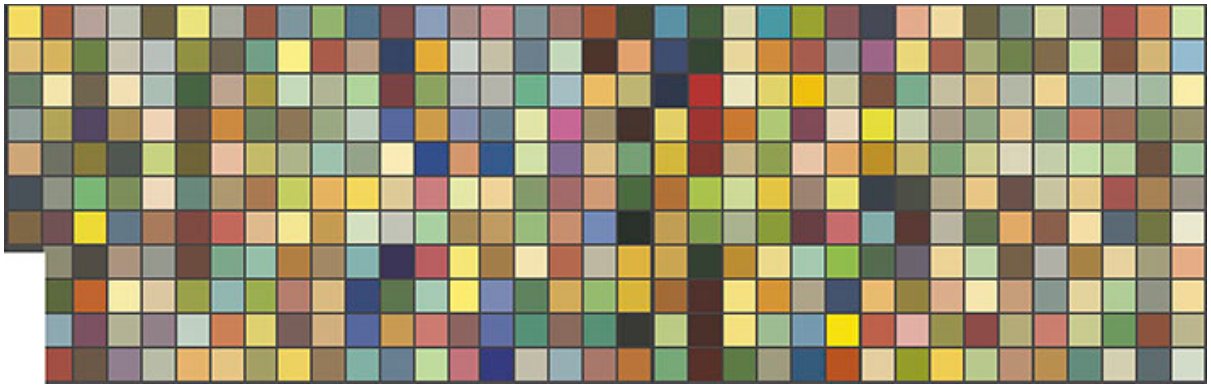


Figure 72 Gooby, B. (2020) Anatomy of Colour (2017), Colour Palette derived from measuring paint colour charts from Interwar period

Figure 73 Gooby, B. (2016) 1930s Colour Palette derived from Pantone© – Twentieth Century in Colour

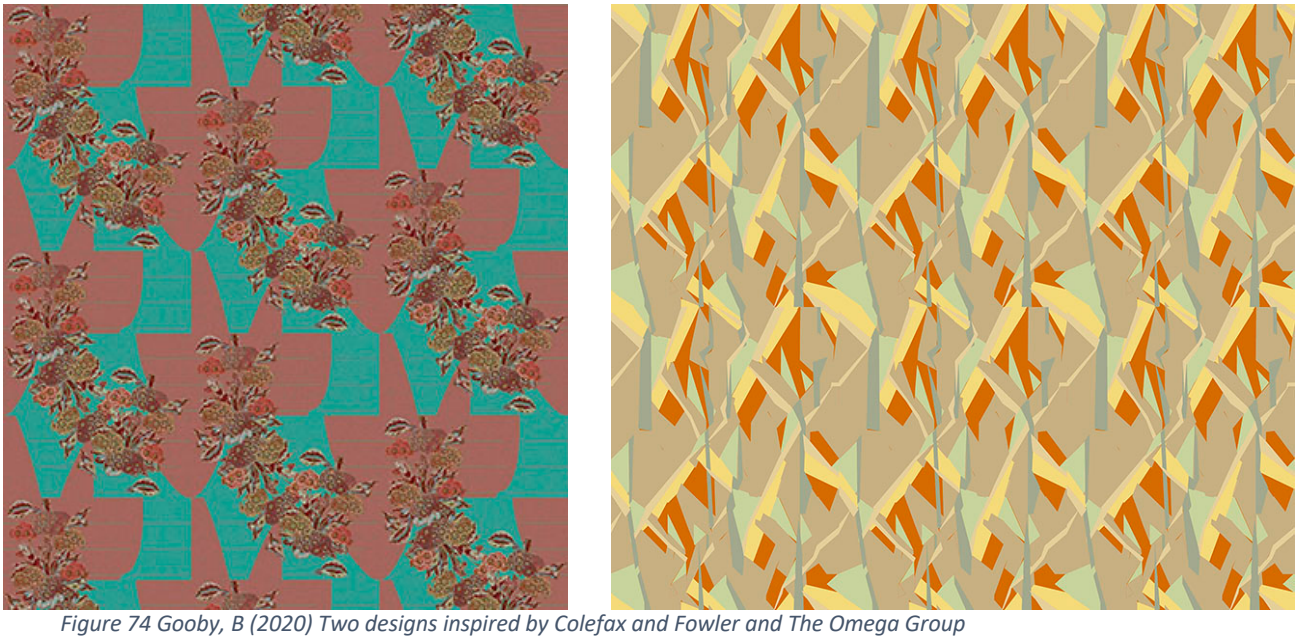


Figure 74 Gooby, B (2020) Two designs inspired by Colefax and Fowler and The Omega Group

Thus, additional designs were developed after seeing exhibitions of The Omega Workshop[69] and Vanessa Bell[70] work and a final design was based on Colefax and Fowler's frequently used motif of the auricular flower examples of which are shown in Figure 74. In total 11 designs in 144 colour ways and 4 colour palettes were created with supporting material in sketchbooks and mood boards and a reflective blog to achieve Objective 6 create a historical archive of colour use in the British Interwar period and Aim 2 create a historical colour palette for testing.

4.6.6 Testing the Modality of Visual Colour Methods

To achieve Objective 7, test and apply the colours from the historical archive , the modality of visual colour methods were applied to the generated body of design work to ascertain their value and accuracy.

A sample of each design and colourway was printed onto the four Textile Substrates (wool, linen, cotton, and satin) and compiled into sample books, photographed in Figure 75. Visual examination of the fabrics was conducted, and the books were annotated with observational comments. Visual observation is a familiar techniques in textile designer's professional practice and draws on the *designer's eye* as a tool, built up from experience. For example Be Fab Creative of visual observation "*some people see colour detail..because I was working a lot more…I'd know they don't (look the same)"* (Appendix F, p12). Designer Consultant A said, *"I'll get to know the different colours that we're working on and what to do with them"* (Appendix F, p39.) and *"I really take pleasure in seeing the colour differences on…fibres and to be honest it wasn't something I felt like I was ever taught"* (Appendix F p40). Helle Albild, Bugi Studio, talked about her trial and error, experiment and experience technique to build up internal colour knowledge saying she'd "*worked with colours for many years"* (Appendix F, p74) to enhance her *designer's eye.*

Figure 75 Gooby, B (2020) Photograph of the sample books which included a physical prints of every design on the four different substrates, annotations and inspirational imagery which were exhibited within the Exhibition of Praxis

Nineteen colours from these prints were identified by the researcher as the most problematic. Identification was based on observed clear difference between screen colour, further colour differences across the substrate prints, and impact on the effect of the overall design aesthetic. This set of colours are shown in Figure 76. These colours were converted into the closest Pantone© reference match by using the colour picker tool in APCC to select from the digital .ase colour palettes files, to be able to look up corresponding swatches in the Colour Reference Book as per first method in modality. It became apparent from visual observation and examination of the colour data that several of converted Pantone© references were very similar or indeed the same reference, despite being taken from different but similar hues, with diverse colour data, from the colour palettes. The conversion exercise was therefore repeated several times but eventually some colours had

to be discounted because the Pantone conversion was not able to discern between them. This reduced the colour set to fourteen. The colours were observed to range from dark, earth, blues and greens, a range of neutral achromatic colours, strong earth reds and yellow and several paler purples, and magentas.

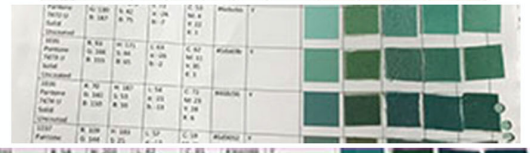
Colour Reference Book

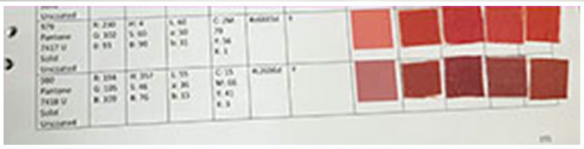
The printed designs were compared with the corresponding swatches to see whether an examination of the individual swatches would have identified that these colours would have been a challenge to print. The observations were recorded and documented, see Appendix G.

Figure 76 Gooby, B (2020) Interwar Colour Set identified for assessment

However, further colour data conversion issues materialised as several of the Pantone© references were observed to be a poor match for the original flagged printed-colour in the design samples. These have been photographed and shown in Figure 77. This further highlights how conversions between colour spaces and colour tools, in this example the colour picker, are not reliable. Therefore, of the fourteen in the challenging colours set only six of the Pantone© colours appeared to be a close visual match to the original set, flagged

challenging to print. The colour set was observed to consist of a dark earth green, light earth green, dark grey, strong earth red, bright pink, and a pale earth yellow.





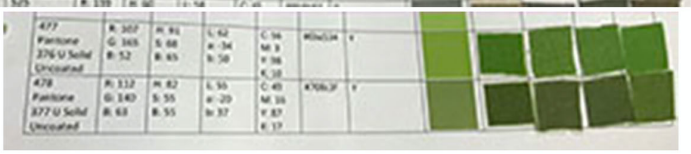


Figure 77 Gooby, B (2020) Photographs of the corresponding swatches from the Colour Reference Book

Digital Lab Dip Tests and Colour Maps

Next digitised lab dip tests, for each of the four substrate swatches, was created for each of the final reduced set of six colours. These are shown in Figure 78, using the method outlined p176, and plotted onto the Colour Map template. A complementary colour map with an indicator colour created using mean average data from Table 9.

Of the six hues, four offered a good indication of how a colour might print in comparison with the printed samples and swatches, and two did not. All the swatches showed a loss of brightness and saturation and a movement in hue value upon examining the measured colour data. This was in line with the 2-5 degrees and 10-20 percentage losses demonstrated in the initial colour map exercise. The two colours whose indicator map was not a good match to print outcome, were the dark grey and the bright pink. The pink swatches, Pantone© 5155, had considerable hue value differences to the screen-colour, beyond the numerical median average calculation. Grey hues had observed in the initial mapping exercise as having large hue value differences when measured, yet this was not found to be the case for Pantone© 415.

Figure 78 Gooby, B. (2020) Colour Maps for the Interwar Colour Set

Indicator Substrate Profiles

Finally, the four different indicator substrate profiles, method as per p193, were applied to all fourteen designs from the problematic to print-colour set. Several designs featured more than one challenging colour. The differences on screen were visually compared with the printed versions to determine whether there was a considerable likeness and if therefore this was a suitable proofing method.

Observational notes include '*The cotton is much pinker and darker than the applied profile suggests. The linen is a good match, the wool is similar, but the silk is not as pink'* in relation to a design with 67 Pantone 134C , a buttery yellow, and '*The applied profiles are very similar to the prints except the linen which is cooler than the applied profile indicates. The silk and cotton are very good matches. The wool is darker and whilst the yellow is similar in tone the background is not. Overall the tonal change is a good indication of how this design will print even if it is not precise'* in relation to 477 Pantone 376, a forest green. Full observations and comments are detailed in Appendix G.

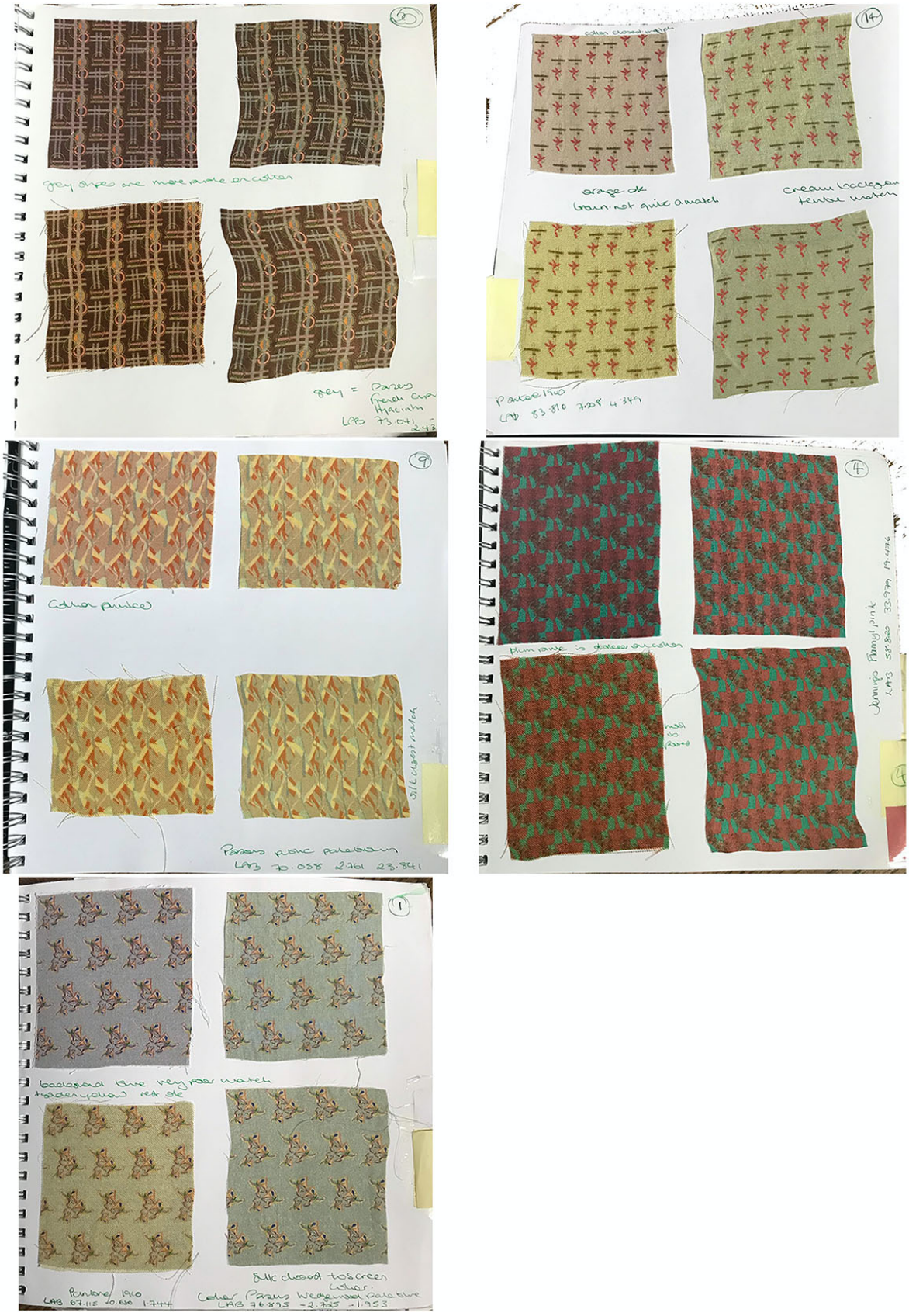


Figure 79 Gooby, B (2020) Photograph of various designs printed onto cotton (top left), linen (top right), wool (bottom left), silk (bottom right) as a comparison with the digital indicator images in Figure 80

Some of the printed examples are shown in Figure 80 and the original screen image (first left hand image) and indicator profiles in Figure 80. There appear to be alterations between the different substrate prints to the original screen image. When comparing the applied indicator with the physical prints there are some correlations and some disparities. For example, the linen indicator profiles, third from left, are all more muted, the silk indicator profiles far right, all appear bluer, something the researcher observed in the physical prints. The dark brown design (top left Figure 79) does appear to show more muted colours in all of the physical prints which is reflected in the digital indicator profile versions. Likewise the yellower design (middle left Figure 79) appears to undergo similar colour changes to digital indicator profile versions (Figure 80 bottom row). However a bluer design (bottom left Figure 79) is less comparable with the digital indicator profiles (Figure 80 top row) which appears to be pinker, whereas the physical prints appear greener or yellower.

For six of the fourteen hues tested, classified pink, red, green, yellow, and brown colour ranges ,the assigned print profiles appeared to provide a general indication of colour changes in the printed output However, when it came to more challenging colours classified blue, purple, and pale achromatic shades, the assigned profiles appeared not as reliable in predicting the expected print-colour. Therefore, their precision was limited.

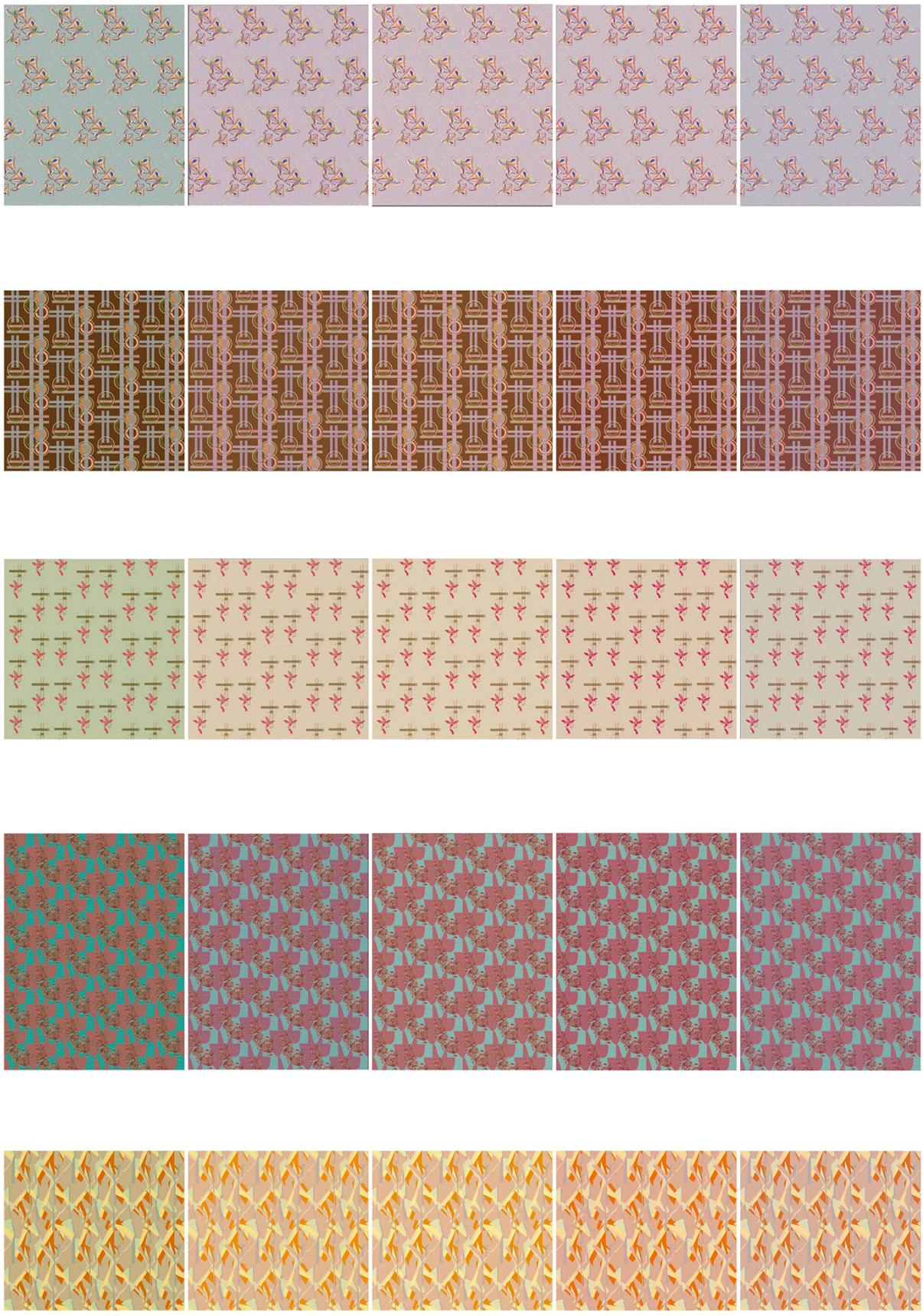


Figure 80 Gooby, B (2020) A selection of designs with the visual indicator profiles applied. From Left to Right: Original Design, Cotton Profile, Linen Profile, Silk Profile, Wool Profile

These activities address the research questions around Colour Archive in that historical colour use was drawn upon (RQ4) to inform colour aesthetics in DTP (RQ3) and the study has used historical colour to test and inform colour aesthetics in DTP (RQ3). The work aligns with improving Colour Expectation as a mechanism for applying the modality, an outcome from addressing RQ1 and 2. Additionally, the colour conversion issues further highlight the significance of gamut mismatches, numerous variables, and adapted technology in controlling colour in DTP. Further research would be required which replicates this activity with external users, to incorporate multiple perspectives and corroborates the findings, in particular the visual observations.

4.6.7 Summary

Designers from the British Interwar era talk of the rigour required to meet manufacturing concerns as well as the excitement of the marvellous machine (Thomas, 1979; Marx, 1980). Industry organisations such as the Design and Industries Association produced guidance and standards that could be utilised by designers and manufacturers alike to support this challenge. DTP has introduced a similar change to the production of printed textiles. This inquiry therefore calls for trade and industry bodies such as the SDC, ASBCI, Textile Institute (TI), and UK Fashion & Textiles (UKFT) to adopt policies from the past and produce standardisation to support designers and the print industry working with DTP.

Through an application of colour knowledge, to a specific colour palette and body of work derived from historical archival research, the inquiry set out to produce a real-world test case. In evaluating the colours identified as challenging to print using the visual colour methods, the research suggests that the modality has some value, although there were some anomalies and much improvement through refinement is required. The indicator substrate profiles especially appeared to be useful but frustratingly not for all colour ranges. It is worth noting that colour conversion issues, leading to the reduction of the colour set meant that a broader range of blues, magentas and achromatic colours were not able to be evaluated. Moreover, the application of colour knowledge in this manner has yielded valuable lessons for the investigation for future research to refine and improve the proposed modality.

4.7 Conclusion to Experimental Chapter

Preliminary exploration focused on establishing the influence on colour of variables from textile chemistry, colour management and production processes. This evolved into the creation of a Colour Reference Book which sought to evidence that there is a colour difference between screen and printed-colour, and establish further alterations between substrates. In this instance, and from accounts of industry experts, achromatic colours and hues with a high magenta or blue tone were flagged as problematic, and thus, will require careful consideration when choosing a colour palette and in the proofing stages. The research envisages this as a resource to provide designers with a sense of how substrates influence printed-colour, as a colour chart download, and as a reference tool for examining and comparing colour data, as well as an indication of colour changes across substrates to enhance colour expertise, highlighting visually, challenging to print colours.

A colour diagram was created to visualise digital lab dip tests, mapping HSB changes for prints on different substrates and posing indicator colours to support colour expectation knowledge. The maps appeared to reveal that detailed colour testing and adjustments will be required to obtain satisfactory colour matches, particularly for prints on wool, silk, and linen. Blacks, magenta tones, cooler blues, and greens demonstrated the greatest hue shifts and changes to saturation and brightness, supporting conclusions from the Colour Reference Book. Likewise the diagrams seek to support designers' colour expectation knowledge and make alterations to designs accordingly.

Finally, visual indicator ICC profiles were developed to visualise colour shifts on screen influenced by printing onto different substrates. The results whilst subtle, seek to allow a designer to detect which colour ranges may need adjusting when choosing an end substrate.

Through applying the colour knowledge and modality of visual colour methods within a real-world test scenario with a specific colour palette from recreating colours from the British Interwar period to address *How historical colour use can be used to inform colour aesthetics in DTP* (RQ3) and surveyed *How colour developed in this period* (RQ4), the research

appeared to demonstrate some value, and the need for improvements, presenting numerous exciting avenues for future research. Moreover, it highlighted the complexity of finding universal solutions for colour in DTP.

As outlined in Chapter Three, the research proposes several significant challenges which contribute to screen to print-colour differences in DTP, gamut mismatches, numerous variables and adapted technology and processes. In addition, the removal of the designer from the print process and inconsistent design education around DTP, impedes ability to problem solve and resolve colour matching issues. The modality of visual colour methods, therefore, been developed to support designers to feel colour confident when digitally printing on cloth. They form part of a Project Tool-kit, which seeks to present guidance around the measures that a designer must take (RQ1) alongside foundational knowledge on colour theory and production methods so that they may be understood and utilised by the design community (RQ2) to improve Colour Expectation.

Explanation of presenting laboratory results as an Exhibition of Praxis

The physical presentation of these experimental activities - laboratory results and findings formulated as textiles and colour work – as an Exhibition is of particular value. This is partly due to the subjective nature of the visual phenomenon of colour, and tangible and material consideration required of inspecting fabric, which is challenging to describe in text alone. However, importantly exposition provides a unique opportunity for audiences to access the research findings, as a tool for communication. In particular the curation of the results in a timeline sought to establish connections and developments between the experiments, felt important for understanding the unfolding of the research inquiry and why decisions were made. Furthermore, as a considerable domain of research was covered beyond a singular field, presenting a visual narrative provides connections and clues to enhance coherence and highlight the five significant challenges proposed (Maeda et al, 2013). Additionally, the Exhibition sought to showcase the modality of visual indicator methods and application in the British Interwar Case Study as a tool for communication and acceptance.

The following concluding chapter summarises the findings of the research project to provide a comprehensive presentation of the project outcomes, their significance, and the contribution of original knowledge.

Chapter Five

Conclusion

Chapter Five concludes the research narrative. It summarises the inquiry and outlines the contributions to knowledge including exploring and developing a modality of visual colour methods, gathering industry experts accounts of experiences with DTP, and offering a real-world test scenario. The findings of these activities propose five significant challenges which make achieving colour in DTP problematic. The chapter concludes with the viewpoint that developing visual colour methods for designers is of value, that a multiplicity is necessary for examining colour in DTP necessary and that the inclusion of designers voices as *colour determiners* is crucial to foster creative potential and develop new and entrepreneurial business model.

5.1 Introduction

The inquiry evolved out of a desire to address the challenges of colour matching in DTP and provide support for designers using this technology so to maximise its potential. This is because DTP offers designers unprecedented opportunity to explore new entrepreneurial business models as evidenced by the accounts of industry experts in the Colour Conversations. However, designers often face difficulties when experimenting with numerous variables to achieve accurate colour outcomes, which can be time-consuming, costly, and imprecise.

Supporting designers in this process is crucial because they play a key role in directing and commissioning colours in textile design as *colour determiners.* Unfortunately many designers lack access to, and an understanding of, the tools and support to improve colour accuracy. This is because barriers to entry to research in this field, primarily scientific and technological, include subscription to access publications and technical language. Moreover, there is a lack of the designer's perspective within in current research.

Financial constraints hinder designer's access to colour measuring equipment, specialist software and technology, and the necessary training. Commercial sensitivity within industry further limits openly accessible and sharing of information. The absence of industry standardisation or best practice guidance adds to the challenges faced by the design community, as defined p22.

In considering the measures that designers must take to feel colour confident and considering the foundational information from scientific theory and production processes that might be utilised, this project aims to empower designers, enhance their understanding of colour matching in DTP, and bridge the gap between scientific research and practical application in the design field.

The inquiry has utilised Nelson's Know-How, Know-What, Know-That model, to adopt a multi-mode epistemological approach. The three interconnected pathways to knowledge have been used to investigate themes of improving Colour Expectation and Colour Archive test. In acknowledging the multiple possibilities and relational influences of colour the study has been able to contemplate multiple perspectives, and review strategies through a responsive, naturalistic, and real-world focus, as typical for a PaR methodology and practitioner-researcher working methods. This has been supported by qualitative elements, two Case Studies, which integrate experiences of DTP and practical and tangible examples of the strengths and weaknesses of tools for preparedness through applying colour knowledge via the modality.

To understand the colour problem and review the tools for preparedness a Contextual Review of the external research and declarative knowledge was undertaken. Importantly this included a range of practitioners' approaches to highlight their contribution to knowledge. This work revealed five significant challenges which complicate and impact colour in DTP. Here gamut mismatches between screen and printer colour spaces occur dues to colour conversion issues, colour exclusivity and colour management processes which fail to accommodate the unique variables and inconsistent textile characteristics in DTP. The adaptions and compromises made from digital paper printing and traditional colouration introduces further complexities, such as splitting the textile chemistry into

distinct and separate phases which introduces further variables and increases potential for additional complications and errors.

Design education is outdated and focuses on traditional subtractive colour mixing, overlooking the importance of digital colour and underpinning colour management processes. Moreover, engagement with DTP from designers without a textile educational background leads to many being ill-equipped to resolve or understand colour challenges in relation to textile characteristics and colouration. This is further compounded by the outsourcing and remoteness of the production process where the printing is done in the designer's absence, further hindering understanding. Designers engaging with DTP employ various strategies, combining objective and subjective approaches, but issues still persist. Finding a universal applicable solution remains challenging due to the complexity of colour and the lack of standardisation and best practice guidance from industry organisations.

In light of these challenges, the value of a tool-kit and a modality of visual methods lies in the ability to provide flexible and adaptable guidance, practical examples, and foundational knowledge for designers to navigate subjectivity and barriers associated with colour assessment. As well as an indication of colour alterations, the tool-kit seeks to build upon established colour expertise of the *designer's eye.*

Nelson's model prescribes a number of techniques to mitigate bias and the subjectivity of positionality, key to the Know-What works mode of knowing. For the inquiry this importantly included incorporating multiple perspectives through a significant Colour Conversations series. Accounts from industry experts which presented the strengths and weaknesses of current textile practices. Furthermore, regular critical reflection through critique and peer review, as typical for creative investigation, occurred with academic experts and specialist technicians who raised as exciting the demonstration of colour influence as a sufficient and valuable tool for communication and acceptance for the design community.

The work was also presented at expositions and in conference paper presentations at international colour and textile conferences. Further reflexivity was introduced by using constant questioning methods of visual observation coupled with annotation, sketchbook

work and documentation as well as audio reflections, a reflective journal and blog. Transparency was maintained through prefacing and signposting the researcher's Know-How and rationale for undertaking the inquiry, whilst acknowledging limitations of research undertakings.

Recommendations for next steps – external testing of the research elements

A major constriction to incorporating external user testing to strengthen and consolidate the research findings was the impact of the COVID pandemic which resulted in the cancellation of workshops to test the Project Tool-kit and modality. Additionally, there were plans to host the Exhibition of Praxis at a prominent arts venue in Bristol, with the intention of inviting members of the industry and design community to attend which wasn't able to happen.

Future research would, therefore, involve conducting external user testing of the tool-kit to enhance its efficacy and serve as a means to assess its usefulness and evidence of value, as well as informing potential modifications for improvement. This approach holds the potential to enhance design education by engaging student cohorts as test groups in constructing the toolkit, thereby demonstrating its provision of foundational knowledge to the design community—a knowledge aspect that was previously deficient in design education or only accessible through commercial experience.

Restaging the key outcome of an Exhibition of Praxis, in different locations and inviting audiences from the industry and design community, would gather valuable feedback regarding the comprehensibility of the project's findings and practical application of the modality of visual colour methods. This process would also offer an opportunity to engage with more designers to develop further opportunities for user testing.

Evaluation of Aims, Objectives, and Research Questions

5.2 Aims

In order to set goals and maintain scholarly structure a set of aims, objectives and research questions, were proposed at the outset of the project. These were encompassed within two themes of improving Colour Expectation and Colour Archive test.

The Colour Expectation theme and Aim 1, *Developing a resource for artists, designers and SMEs which provides guidance on improving colour matching in DTP* has been addressed and achieved by carrying out Objectives 1-4. The results of which have been formulated into an Exhibition of Praxis presenting the influence of textile chemistry and colour management on colour outcome, showcasing the modality of visual colour methods, and demonstrating their application in a real-world test scenario through the British Interwar Case Study. This work, and guidance in the form of foundational knowledge[71], and presenting the benefits and uses of DTP, has been assembled into a Project Tool-kit as an online, accessible website. The website also details the Colour Conversation Case Studies[72] to evidence the multiple perspectives of industry experts in the textile industry alongside other resources such as downloadable test files, a reading list and glossary[73].

The Colour Archive theme and Aim 2, *Creating an historical digital colour palette which, drew upon colours from this era to create a specific colour palette and design work*, as a real-world test scenario, has been achieved through the undertaking of Objectives 5-7 as a British Interwar Case Study which formed part of the Exhibition of Praxis and is and presented as an application of the inquiry's colour knowledge on the Project Tool-kit[74].

5.3 Objectives

The projects objectives have been met by the body of colour work and key outcomes as presented across Chapter Two – Methodology, and Chapter Four – Experimental, in relation to the research questions.

To meet Objective 1, *Survey and compare different digital colour printing systems for textile designers*, a Contextual Review was carried out which looked at the different mechanisms and print environments available for replicating colour in DTP. This led to praxical experimentation exploring the key variables that influence colour in DTP. Additionally, a set of recommendations for colour tools and practice for designers and SMEs which is detailed in Table 6 was made. This work sought to demonstrate that gamut mismatches, numerous variables and adapted technology all contribute to the challenge of colour outcome in DTP. This is exacerbated by the plethora of tools and support services available many of which are not universal and are imprecise[75]. Furthermore, the abundance of options makes it challenging to make informed decisions, and choose the most suitable option for the designer's circumstance, especially in relation to the scientific aspect of non-reproducibility outline in Chapter Two, where a myriad of printer environment and production conditions make replication and thus colour control impossible.

To meet Objective 2, *Use interviews and case studies to identify the strengths and weaknesses of current textile printing practice*, and Objective 3, *Co-ordinate a network of experts to facilitate a series of case studies titled Colour Conversations*, fifteen purposeful conversations with industry experts were undertaken. These demonstrated that designers had developed tools for preparedness which included reducing or controlling variables, focusing on developing a good relationship with their print bureau and building their colour knowledge using their *designer's eye.* Some used established colour management practices, acquired through commercial experience, combining additional tacit adjustments using their built up colour knowledge. For others, colour management approaches were not part of their professional practice due to lack of access or understanding, or were not considered important because using visual, subjective approaches had proven more effective or accessible. This work sought to demonstrate that the significant challenges of inconsistent

design education, lack of industry standardisation and a remote and outsourced production process contribute to the understanding of colour issues in DTP and how to resolve them.

To meet Objective 4, *Establish a coherent body of colour work using DTP*, praxical experimentation leading to the evolvement of a modality of visual colour methods was undertaken and presented as an Exhibition of Praxis. Preliminary progressive and demonstrable experiments considered the influence of altering variables on colour outcome. In particular textile chemistry, colour management and printer production processes. In addition, knowledge gathered through the Contextual Review and corroboration from industry expert accounts, supported the arising premise that the substrate, a variable within the control of the designer, had a significant impact. Thus, exploration of supportive methods focused on colour alterations by substrate. This work developed into a Colour Reference Book, Digital Lab Dip tests and Colour Maps and a set of Visual Indicator Profiles which could be applied on screen, seeking to support designer's *'internal colour look-up tables'* (Appendix F p103.) so that they could be empowered to anticipate and resolve colour issues in the design stages, reducing costs and the likelihood of reprinting. Furthermore the development of a modality of visual colour methods sought to provide designers with tools to envision changes in individual colour chips as well as within an overall design. The work sought to demonstrate the significant challenges arising from gamut mismatches, numerous variables, and adapted technology.

To meet Objective 5, *Undertake a historical literature survey*, Objective 6, *Create a historical archive of colour* and Objective 7, *Test and apply these colours,* historical archival research was undertaken complemented by a literature review of the British Interwar era and visits to exhibitions, to generate a specific colour palette and body of design work as a real-world test scenario to apply colour knowledge using the modality of visual colour methods. The findings of the study clearly highlighted the immense difficulty in resolving colour issues in DTP and although the methods offered some value, they were not without their limitations and encountered certain issues around colour conversion. However, through using a visual example and a familiar mechanism of drawing on archival research for design inspiration, to comprise a real-world test scenario, the case study sought to present the research findings in a format familiar to designers as a tool for communication and acceptance.

The physical presentation of laboratory results activities here holds significant value as exposition allows audiences to directly engage with the research findings, see the unfolding of the research inquiry to make connections across experiments, and as a mechanism for showcasing the outcomes. This is especially important due to the subjective nature of colour perception, as well as the materiality of fabric, which means that descriptive text alone cannot effectively convey the physicality and visual nuances in colour changes.

5.4 Research Questions

Research questions encompassed by themes of improving Colour Expectation and Colour Archive test, held and guided the inquiry. These were addressed through undertaking the aims and objectives as outline.

In addressing RQ1, *What measures must a designer take*, the inquiry concludes that whilst the scientific and creative aspects of non-reproducibility make it impossible to completely resolve the problem, there are measures that designers can take to mitigate colour issues in DTP. These include controlling variables such as limiting the number of substrates they choose to print upon, considering the impact of gamut mismatches and textile chemistry on colour outcome, and employing effective colour management practices such as regular screen calibration, assigning appropriate profiles and colour sampling. Designers should also actively engage with their digital print bureau, asking relevant and informed questions and seeking clarification on any uncertainties over print outcome . Further solutions are offered such as utilising design movement (patterns, gradients, pixel textures and filters) and avoiding areas of flat colour to disguise colour discrepancies. Some colour ranges appeared to be more problematic to print in this instance, particularly blues, magentas and neutral achromatics such as greys, blacks, and pastels, and were also raised by the industry experts as challenging. However, due to the myriad and range of print environments and production conditions, there is the potential that a set-up exists which will achieve improved colour fidelity with these hues. Therefore, it is not recommended that designers avoid using these colour ranges altogether, but should incorporate careful colour sampling practice which includes a wide range of neutral, blue, and magenta tones as significant colours for testing out a print bureau.

Ultimately, the solution that the inquiry evolved is the modality of visual colour methods which seek to support designers colour knowledge, building *designer's eye* in colour expertise by providing an indication of how colours might print so that they can resolve colour issues in the design stages. Evaluation conducted with the British Interwar Case Study revealed, there is a need for further development to address the challenges associated with printing harder-to-print-colour ranges. Therefore, next steps would involve iterative,

calibration experiments to improve the methods. Future research would seek to refine further through external user testing to assess the replicability of these methods within the design community and gather evidence of their value in order to improve them.

In addressing RQ2, *How can the design community understand and utilise scientific theory and DTP production,* the inquiry concludes that in sifting and reviewing the research that basic information about DTP and foundational knowledge on textile chemistry and colour management is useful to support the understanding and utilisation of colour in DTP. This has been initially provided on the tool-kit[76] supported by resources[77], downloads and a reading list[78]. This seeks to address the inconsistent design education and variations in designer's commercial experience of DTP which many of the industry experts said helped them navigate colour challenges in DTP. External user group testing would demonstrate the value of these resources and how they were used.

In addressing RQ3, *How can historical colour use inform DTP* and RQ4, *How did colour use develop*, the inquiry concludes that observing the development of historical colour use and reflecting upon responses to new manufacturing technology, including access increased availability of colours, was of value to inform colour aesthetics in DTP. From examining the literature and undertaking historical archival research, the inquiry was able to observe colour use from a different era and make analogies with designer responses at the time to that of the industry experts in Colour Conversations. Several organisations were established during this era in response to technological and colour chemistry innovation. These addressed the changes by proposing best practice and industry guidance. As an emerging technology, DTP could benefit from such guidance from current industry associations such as SDC, ASBCI, TI, and UKFT so that it may be utilised by designers and manufacturers alike.

Importantly in drawing upon this period, the inquiry was able to generate a specific colour palette and body of design work as a Colour Archive, and present an application of colour knowledge as practical validation of the research findings in a relatable way to the design community. Whilst there were limitations, this undertaking offered an example of value, as well as showcasing the complexities of resolving colour in DTP.

5.5 Outcomes and outputs

The outcomes and outputs produced by the project are 1) an exhibition of colour work comprising of printed textiles and associated material, formulated as an Exhibition of Praxis, 2) a modality of visual colour methods which seek to support designer's understanding of colour changes in DTP; Colour Reference Book, Digital Lab Dip Tests and Colour Maps, and Indicator ICC Profiles, 3) Colour Conversations – fifteen purposeful Case Studies detailing interviews with designers, SMEs and industry experts about their experiences of DTP, strengths and weaknesses and their tools for preparedness, 4) British Interwar Case Study – an historical colour archive used to test the modality 5) an accessible, online, tool-kit comprising guidance and documentation of research findings.

The Project Tool-kit can be found at digitaltextilecolour.org and continues to be developed with the vision that it will become a user generated, source of knowledge for the design community to empowering them and provide a voice as *colour determiners* in the DTP process and future research in this field. Appendix E documents the tool-kit at the date of submission.

Furthermore, exposition and dissemination of the research has been carried out through exposition at DataAche, Plymouth 2017, Gallery Kopio, Finland 2017, UWE Bristol Oct-Dec 2017 and at annual UWE Bristol Research Celebrations. Dissemination includes poster presentations at Progress in Colour Studies London 2016, Textile Institute Textiles and Life, Manchester 2017, World Textile Institute Conference Leeds 2018, and International Colour Association (AIC) Portugal 2018. An openly accessible journal article was published in Journal of Textile Design Research and Practice in November 2020[79].

How do the research outcomes assist the intended audience for the inquiry

The outcomes of this project support designers' colour knowledge. This seeks to enable designers to improve their creativity with DTP without feeling frustrated and encumbered by technical issues. Designers will be able to communicate effectively with DPBs because they have a better understanding of the variables that affect printed-colour outcome, achieving more accurate colour results (McKeegan, 2017).

The inquiry has sought to provide accessible and relatable outcomes for the intended audience through exposition of visual material, seeking solutions through visual methods, gathering designer accounts, providing a practical and tangible example for testing, and compiling the research findings and information into an online accessible website as a tool-kit. Furthermore, research publication was made in a journal aimed at textile designers and practitioners.

Significantly, the inquiry has reviewed and explored, through praxical experiments, the gamut mismatches and numerous variables that impact colour in DTP to provide foundational knowledge to focus on essential aspects and make informed decisions. It has sought to develop solutions which aim to enhance existing colour expertise of the *designer's eye.* This approach was cited by industry experts as a valuable and practical method for working with DTP. Through providing indications of colour alterations when printing on different textile substrates from materials such as colour swatches, colour data, digital lab dip tests, colour maps and indicator substrate profiles the inquiry seeks to allow designers to resolve colour issues in the design stages.

As an additional note, the inquiry has presented several exciting opportunities for creative potential including multi-pass printing to create overprint colours and three-dimensional colour affects, using pre-coatings to print motifs and re-print on existing garments or combine further textile and printing techniques with DTP, and hacking colour profile processes to experimentally alter colour processes. This latter technique was further explored in the *Ways of Making* Project which is detailed in the journal article (Gooby, 2020).

5.6 Originality, new knowledge, and significance

This research project fulfils a gap in knowledge as a praxical investigation of colour in DTP from the perspective of a designer which bridges science and art, to intersects several research specialisms (colour management, textile chemistry, printer technology) as a multiplicity approach. The project contributes original knowledge by visualising the influence of variables on printed-colour outcome through praxical experiments, and has explored and developed a modality of visual colour methods to support designer's knowledge.

Using PaR is a novel and less typical approach for colour in DTP. Thus, creates a unique inquiry, and therefore original outcomes. The studio-based modus operandi has allowed praxical and real-world experimentation using a multi-modal, cyclical methodology, incorporating moments of reflexivity to centre *'thinking-doing'* at the heart of the inquiry. Ideas have been processed and explored directly through printmaking and colour work, leading to a deeper comprehension of theory and concepts beyond the prevailing skill-set of the researcher. This has generated distinctive insights into research problems typically investigated using scientific methods and disseminated through text. For example, this project is the first to collate and test the variables that affect colour outcome in DTP and present the resulting experiments within an Exhibition of Praxis, as a key outcome. A textual comparison to this would be Ujjie's Digital Textile Printing in the Woodhead series.

This new knowledge can be summarised as 1) a practical body of colour work investigating the influence of variables on printed-colour outcome formulated as an Exhibition of Praxis, 2) the development of a modality of visual colour methods to support designers 3) a unique application of colour knowledge in form of British Interwar Case Study, 4) Colour Conversations Case Study – fifteen purposeful conversations gathering the experiences of industry experts on their engagement with colour and DTP, 5) Project Tool-kit – Openly accessible pedagogical tool about process, impact of variables and demonstration through practice and real-world scenarios.

The project explores, and through Praxis builds-upon, many of the concepts from key texts and researchers, as per p38. The inquiry extends existing research about gamut mismatches and the numerous variables that impact colour outcome in DTP and investigates these as progressive, demonstrative praxical experiments. It highlights adapted technology, outsourced production, and design education as significant challenges to achieving expected colour outcomes, building on existing studies, by Henry (2013) and Kelly (2014). It builds upon the textual outputs of Ujiie (2006), Tyler (2005) and Carden (2015) by exploring declarative knowledge through the method of Praxis. The study presents best guidance for designers which is currently lacking in DTP research[80] in the form of the Project Tool-kit and makes recommendations for working practice as per Table 6.

Key contributions to knowledge

A key contribution to knowledge is the modality of visual colour methods. This research has introduced two distinct methods that seek to support colour outcome through visualising screen to print-colour differences. These are undertaken by mapping and visualising digital colour data as Digital Lab Dip tests and as a set of indicator profiles which when assigned to an image, seek to demonstrate on screen the expected colour changes when printing onto different substrates. The study is not aware of any other practitioners altering colour targets to create innovative profiles, nor anyone creating indicator screen profiles to gauge how colours will print across different substrates although user testing is recommended to establish accuracy and usefulness.

Additionally, the research drew upon the existing use of colour charts, to evidence the screen to print-colour issue, both visually and through five different sets of colour data, to produce a Colour Reference Book as a resource for colour sampling and to assess colour differences on substrates alongside colour data examination.

The study identifies and connects five significant challenges which make colour accuracy in DTP problematic and proposes that there is creative potential for designers to exploit the influence of variables. There is a gamut mismatch between the RGB colour space of the screen and the CMYK colour space of the printer (Green, 2010; Cheung, 2012). Colour conversion methods are complex, and compromises are made (Dawson, 2006a; Carden,

2015). These processes have been developed for enhancing colour outcome on smooth, glossy surfaces and do not account for textured woven substrates and textile chemistry (Ding, 2016). Print machinery and textile chemistry have been adapted for DTP causing quality and efficiency trade-offs impacting colour outcome (Carden, 2015). Production is carried out as a commercial service and not undertaken by the designer, obscuring understanding (Carden, 2015). Design education focuses on subtractive colour mixing and traditional print methods to the detriment of comprehension of digital colour and DTP (Kelly, 2014).

Design education needs to include the impact of textile chemistry and colour management variables to provide designers with the ability to ask knowledgeable questions of DPBs and make informed choices about their print environment and end-product. Furthermore the research recommends that colour management processes are developed specifically for DTP which can incorporate data on variables particular to textile substrates such as weave, fibre type and textile chemistry.

The inquiry is significant because the DTP industry is worth 165 billion dollars (Ross, 2018) and colour mistakes are costly both financially and to the environment. It is the role of the designer to utilise and implement colour (Udale, 2014) as *colour determiners* and therefore a significant solution to the issue of printed-colour outcome is to ensure that designers are aware of the challenges in achieving colour fidelity and in understanding how colour is impacted in the DTP process.

This research project seeks to feed into industry organisations and prompt further research, standardisation, and best practice guidance within industry.

5.7 In conclusion

This research has established that achieving colour accuracy and constancy is challenging in DTP. This is evidenced through the production of a body of colour work, experimental Praxis, accounts of industry experts and an application of colour knowledge in a historical archival case study, supported and informed by a Contextual Review. Whilst DTP is an emerging research field the problem with colour accuracy is acknowledged by number of other studies including Carden (2015), Ding (@016), Henry (2013), Kelly (2014), Leak (1998), Tyler (2005) and Ujiie (2006).

The inquiry identifies a knowledge gap where there is limited research on this issue from the designer's perspective, or aimed at designers who are the *colour determiners*. Nor have there been many studies[81] that approach the problem through praxical and visual experiments, or using real-life design examples, other than *how-to* guides.

The research project, which began in October 2015, has over a four-year period[82], used praxical, tacit and external knowledge to investigate why colour fidelity is problematic in DTP. At the outset practical work arose from the existing working methods of the researcher shifting to focus on the testing of different variables to determine their impact, underpinned through gathering accounts from industry experts. This led to exploring and developing a modality of visual colour methods and a real-word test scenario.

The project demonstrates the specific problems with colour in DTP including print consistency and predictability, and the current resolutions provided. It highlights textile chemistry, substrate choice and colour management processes as key variables affecting the colour outcome. The Contextual Review establishes that colour is critical in textiles, and reviews the research to understand the colour problem and the tools for preparedness.

Interviews with industry experts, Colour Conversations identified some emerging themes around engagement with DTP. These deduced that reducing or controlling colour fidelity variables aided colour outcome and it was important to have good communications between designer and printer. The *designer's eye* plays an integral part in colour control, as

does colour testing but that there is a lack of colour management education and accessibility for designers. DTP is creating Entrepreneurial business models in the textile industry. The modality of visual colour methods explored ways to support the designer's understanding of colour in DTP and enable them to be better placed to assess and correct colour mistakes.

Colour management processes use mathematical models and scientific theory to convert pixels to dots to produce perceived colour ranges. Algorithms are automatically performed out of sight and seemingly with little input from the user. Yet, within the study, technology was harnessed to produce aesthetically interesting and experimental colour outcomes retaining designer creativity. This work demonstrates that a designer may exert control in the realm of digital colour printing by manipulating computer algorithms, preserving the *designer's eye* as a tool for colour control.

This has evolved into a standpoint that firstly developing adaptable and flexible visual colour methods which provide indications of colour changes is of value to designers engaging with DTP because this leverages existing colour expertise and deploys a familiar technique of visual clues, already part of the designer's professional practice, to support the development colour confidence. This is viewpoint is corroborated by the multiple perspectives of industry experts who cited visual methods and tools as critical for supporting colour outcomes. These included adjusting settings in design software, colour sampling, relying on built up colour knowledge, termed as *designer's eye,* and gaining commercial experience, to make accurate decisions. Some even called for methods which allowed you to "*see the colours together how they're going to look would be really helpful" (*Appendix F p70), and talked about the benefits of seeing the reality of the limited colour spaces of the printer saying "*it would be more likely to give them a realistic interpretation of what they're likely to get on the cloth" (*Appendix F p32) and that without this information *"you don't know what you're going to get at the end of* it" (Appendix F p18.) and that *"your monitor should not lie to you"* (Appendix F p53). This provided the rationale for developing a modality of visual colour methods and guidance in the form of a Project Tool-kit which supports the designer's colour confidence in DTP.

Secondly, the research holds that a multiplicity is necessary for examining colour in DTP, because singularity approaches (textile chemistry, colour data, printer tech) cannot be applied comprehensively in DTP, due to the numerous variables and myriad of processes involved. Thus, through holistic research, examination and consideration is required of the whole print environment, to be responsive and flexible, and generate accessible information for users who need to understand the entire workflow. This is corroborated by the key texts reviewed by the inquiry Tyler (2005), Ujiie (2006) and Carden (2015), and the approach taken by Best (2012) in examining colour, which demonstrates that to understand the colour problem a range of domains and elements need to be described and considered. However, the uniqueness of this inquiry, however, is that it offers a naturalistic approach through Praxis to generate insight, accessible and visual content to articulate the non-verbal experience of colour and colour differences, and stimulate change beyond academia.

Finally, the inquiry concludes that including the designers' voices as *colour determiners* is crucial to foster creative potential and developing new and entrepreneurial business model for DTP. In addition to establishing a lack of industry guidance and standardisation, a review of research in Chapter Three, noted an absence of the designer's voice or consideration of their role in DTP. This is significant because as *colour determiners,* selecting a colour that is challenging to reproduce within a specific print environment it generates complications when it becomes clear that the colour is unprintable.

Overall, this research emphasises the significance of visual colour methods, the need for a comprehensive approach to colour examination, and the importance of including designers' perspectives in the DTP process.

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List of Appendices

These are provided as separate documents and should be viewed in conjunction with the thesis material.

- A Glossary of terms, including technical descriptions
- B Methodology terms and descriptors
- C Documentation of Exhibition of Praxis
- D Reflections on Praxis Work
- E Documentation of Tool-Kit
- F Colour Conversations Case Study: Transcripts and Summaries and Consent forms
- G Interwar Case Study: Exhibition Handout, and the data analysis
- H Data Analysis of Colour Reference Book

Notes

[1] In the context of this inquiry the term praxical and Praxis are specifically used, as per Nelson's model, to emphasise the overlap between practice and theory and to underscore the scholarly activity.Typically practitioner-researchers will describe their method as practice and so the terms may also be viewed as interchangeable. In describing PaR methodologies therefore the term practice and practical are also used as generalities.

[2] Material has been examined by Society of Dyers and Colourists (SDC), Association of Suppliers to British Clothing Institute (ASBCI), Textile Institute (TI)and UK Fashion & Textiles (UKFT) as well as British Standards and none refer to digital textile printing in colour guidance

[3] The cost of a one-day course on digital textile printing with the Textile Training Group cost £345, an introduction to colour measurement cost £325, and digital colour management cost £325. A one-day training bespoke training on colour management with Revolution Digital cost £750

[4] Variations begin with fibres generation which as derived from organic sources are non-uniform, as well as fibre preparation (carding and combing, spinning, sizing, weaving, singeing, desizing, scouring/bleaching, mercerizing), and incorporates colouration instabilities, lack of accurate colour data conversion, and the conditions of the day that the printing is carried out (temperature, humidity).

[5] In the context of this inquiry the terms praxical and Praxis are specifically used, as per Nelson's model, to describe and underscore the scholarly activity undertaken in the inquiry to emphasise the overlap between practice and theory. Typically practitioner-researchers will describe their method as practice, and so the terms may also be viewed as interchangeable. In describing PaR methodologies, therefore, the term practice and practical are also used as generalities.

[6] **Impact of changes in technology** - Paul Laidler is a practitioner-researcher who focuses on the impact of digital print and technology within fine art processes. Laidler uses a combination of methods such as printmaking practice alongside other data-gathering activity (artists' statements, studio photographs, screen grabs, e-mail correspondence, documentation tables) to identify how changes in technology have affected traditional, collaborative, print-making strategies (Paul Laidler Phd https://uwe-repository.worktribe.com/output/964903).

[7] **Advancing and informing contemporary practice using traditional techniques** - Lisa Sheppy is a practitioner-researcher whose work seeks to restore and modernise traditional printing techniques - tissue transfer in ceramics. Initially data-gathering through oral history interviews and archival research to gain insider knowledge and a deeper understanding of techniques, she honed knowledge through practice techniques to

develop, test and demonstrate a new method for tissue transfer printing, created specifically for artists by using accessible and familiar tools and materials (Lisa Sheppy PhD https://uwe-repository.worktribe.com/output/9238193/an-industrial-craft-reinstated-a-printmakers-perspective-on-tissue-transferware)

[8] **Examining process for new insights** - Wendy Picken is a practitioner-researcher who explores the concept of creativity in the practice of drawing and etching, by examining both her own practice and that of other artists. Her primary method is examining practice work using an iterative reflective process. For example, focusing on the evolution of working proofs for etching. This is supported by contextual data gathering (theories, sketched paragraphs, initial interviews, transcriptions, exhibition reviews) which combined with practical insight, highlights the significance of creative practice to reveal tacit understanding, material consciousness, and shifts within artistic domains (Wendy Picken PHD https://uwe-repository.worktribe.com/output/1491181/drawing-and-etching-place-what-are-the-experiential-and-material-characteristics-of-british-contemporary-practice-and-how-do-they-evidence-reciprocity-between-drawing-and-etching).

[9] Ding (2016) used numerical data collection from measuring colour calibration and characterisation tests, and dye characterisation (high-performance liquid chromatography, mass spectrometry and X-Ray crystallography) to examine colour in DTP. To gain insights into current practices, Ding established a study group comprised of industry experts utilising interviews and questionnaires which led to a detailed description of current colour gamut analysis and print quality evaluation in DTP with recommendations for future developments.

[10] To make his assessment of colour in DTP Tyler (2005) collected content using a literature review of research and industry data, focusing on the components, technological process, and materials to outline the capabilities, challenges, and future possibilities for DTP.

[11] This research project was part of the 3D3 Research Centre for Doctoral Training, a partnership between UWE Bristol, Falmouth University and Plymouth University fostering innovation through practice research in the creative and performing arts, especially the interrelated fields of digital design, digital media, and digital arts (including music and performance). http://3d3research.co.uk/

[12] The supervisory team consisted of a Professor of Colour, Design and Print (Parraman), the Head of Printed Textiles (Clarke), and an Oral Historian and V&A Fellow (Partington). Specialist technicians were consulted whose expertise were in digital ink-jet textile printing, digital sublimation textile printing and textile colouration (Hill and Henneberry). Members of the CFPR included expertise in colour science, optics (Klein), materials, engineering (O'Dowd), inks, dyes (Hoskins), and textiles (Morgan). Expert academics included a Professor of Design History and Theory (Sugg-Ryan), practice research (Mock, Spicer, Miller and Prior) and digital technologies and design education in relation to textiles (Britt).

[13] A conscious decision was made to use the term PaR as this inquiry views the terms 'practice-led research' and 'practice-based research' as problematic due to the implied separation of practice from the word research which suggests that the research happens separately from the practice, either acting as a guide (Gray and Malins, 2016) or foundation (Gray and Malins, 2016) to the 'real' research. Therefore PaR was used as a term which centres the practice/Praxis as the primary conduit, mechanism, and articulation of the research to effectively engage with the design community who will be familiar with assessing colour samples, colour work and design portfolios, all outcomes of this PaR inquiry.

[14] On page 9, Nelson talks about how he has been 'known to steer prospective PhD students towards more traditional approaches since a PaR process is tough' and that he recognises that 'PaR projects require more labour and broader range of skills to engage in a multi-mode research inquiry than more traditional research processes' (Nelson, 2013)

[15] Nelson's model has emerged as a significant outcome of the PaR In Performance (PARIP) project which aimed to develop national frameworks to promote high standards in representing practical-creative research within academic contexts. Initially, Nelson introduced the model in a book chapter in 2009, and later refined and expanded upon it in his 2013 publication titled "Practice as Research in the Arts."

[16] Miller & Whalley - 2004, Donovan - 2013, Naray-Davey - 2013, Scott - 2014, Drahos - 2015, Matthews - 2015, Ling - 2016 Beale - 2017, Charlton - 2017, Ang - 2017, Mikou - 2018, Wilson - 2018, Battista - 2019, Lambert 2019, O'Toole - 2020, Adams – 2021, Piekarczyk - 2021, Conn - 2022, Kaner - 2022, Ngwe - 2022

[17] Leavy describes the scientific method as that which uses quantitative methods, factual and objective judgement, and evaluation, and holds the principles of validity, reliability, and appropriateness. In qualitative research meaning emerges from labelling, identifying, classifying, testing hypotheses, finding patterns, and generating theory. This is in contrast to the messiness of social science and arts based research which place more emphasis on process, observational skills, analytical skills and storytelling proficiency (Leavy, 2015)

[18] Experiments, initially exploratory and actively seeking understanding through discovery, considered different software techniques/processes (gradients, halftones, and pixels), using software tools, and developing an awareness of colour theory. As the inquiry unfolded a number of experiments were employed to examine key variables of DTP. This preliminary exploratory work is detailed in p.150 to avoid repetition and excessive detail and retain focus on the core activities.

[19] https://www.tandfonline.com/doi/full/10.1080/20511787.2020.1827802

[20] Crysede Archive at Penlee Museum Penzance, Moquette Archive at Transport for London Archive, London and Eileen Hunter Archive at Cloth Workers Study Centre, Victoria and Albert Museum Archive, London

[21] https://digitaltextileprintingblog.wordpress.com/2016/12/18/practitioner-marly-van-lipzig/

[22] https://digitaltextileprintingblog.wordpress.com/2016/12/18/practitioner-eugene-van-veldhoven/

[23] https://digitaltextileprintingblog.wordpress.com/2016/10/03/practitioners-alison-bell/

[24] http://hatleyprint.co.uk/

[25] https://digitaltextileprintingblog.wordpress.com/2016/12/10/practitioner-hil-driessen/

[26] https://digitaltextileprintingblog.wordpress.com/2016/12/14/practitioner-mary-katrantzou/

[27] http://www.tedresearch.net/research/detail/digital-craft/

[28] Gearing and Stack used a mixture of Sodium carbonate, Manutex and Urea to create a coating which was silk screened onto the Damask and left to dry before being put through the digital printer. The work was part of the *Worn Again* project, principal investigator Professor Rebecca Earley, http://www.tedresearch.net/media/files/PROJECT_REPORT_2011.pdf and exhibited at the *Ever and Again Exhibition* http://www.tedresearch.net/research/detail/ever-again-exhibition/

[29] The People's Print describe themselves as 'promoting digital textile printing as a means of production to empower you to create beautiful, bespoke textiles that are original and unique' http://www.thepeoplesprint.com/

[30] http://www.textiletoolbox.com/media/uploads/project-downloads/smoergasboard.pdf

[31] http://www.tedresearch.net/

[32] https://slowtextilesgroup.com

[33] https://digitaltextileprintingblog.wordpress.com/?s=practitioner+list

[34] https://digitaltextileprintingblog.wordpress.com/2016/10/01/practitioners-basso-and-brooke/

https://digitaltextileprintingblog.wordpress.com/2016/12/19/practitioner-susi-bellamy/

https://digitaltextileprintingblog.wordpress.com/2016/12/18/practitioners-timorous-beasties/

[35] The InkDrop Boutique was founded by [TC]2, an organisation founded to research robotics in sewn products industry http://www.inkdropprinting.com/

[36] http://www.lacunapress.com/product-category/designedfabric/

[37] http://www.lacunapress.com/colour-profiles/

[38] Malcolm Cocks used computer coding and Adobe Photoshop to explore weave patterns digitally. His work features in Central St Martin's *Real Dirty Blue* an exhibition on innovative practice in textile design.

[39] Joan Truckenbrod hacked printers and wrote her own code to digitally print onto fabric http://joantruckenbrodart.com/algorithmic-art-tapestries.html

[40] https://digitaltextileprintingblog.wordpress.com/2016/10/11/384/

[41] https://digitaltextileprintingblog.wordpress.com/2016/10/11/practitioners-blackpop-design-2/

[42] https://digitaltextileprintingblog.wordpress.com/2016/12/18/practitioners-timorous-beasties/

[43] https://ncscolour.com/ncs/

[44] https://britishcolourstandard.com/

[45] https://munsell.com/

[46] Leak cites MacDonald's five potential methods for gamut mapping; do nothing, truncate (colour replaced by nearest value on gamut boundary), umbrella (linear scaling of all colours to fit to gamut), non-linear (scale colours near to boundary to within boundary), image dependent (user adjusts colours to best match) p129 Leak, A. 1998. A practical investigation of Colour and CAD in Printed Textile Design.

[47] Dawson lists four methods for gamut mapping; Perceptual (photographic) applied to all colours to retain colour balance, Relative colourimetric (proofing) preserves lightness but not saturation of hue, Absolute colourimetric (match) converts to nearest hue but sacrifices saturation and lightness, Saturation (graphic) maps the saturation of the primary colours in each colour to the saturation in the primary colours of the printer but disregards differences in hue and lightness, which is used in display graphics. Dawson T, 2006 Digital Colour Management *Digital printing of textiles*, Woodhead Publishing. P.163-178

[48] The CIE defined illumination standard for textiles is D65 which represents European daylight (SDC, 2008)

[49] Ujiie's *Digital Textile Printing* devotes a chapter to three printer types, the DuPont Artistri 2020 (Raymond, 2006) a mid-range textile printer, the Reggiani DReAM (Caccia and Nespeca, 2006) a high-end textile printer and the Mimaki T series (Kobayashi, 2006) a low-end printer which is used in most Higher Education Institutes. Cahill in her introductory chapter to the book outlines the history of the development of digital textile ink-jet printers and the types and manufacturers involved.

[50] The Bezold effect causes colour perception to change when small amounts of colours are juxtaposed, such as in a stripe or small-scale pattern. It is named after Wilhelm von Bezold (1837 – 1907) whose experiments with colours discovered that colours could appear differently when placed adjacently.

[51] http://www.virtualcolourcourse.com/

[52] Services such as Pattern Bank https://patternbank.com/, and the now defunct Surface Pattern Print, allowed companies to purchase stock designs, bypassing textile agents and freelance designers.

[53] Material has been examined by SDC, TI, ASBCI and UKFT and none contain best practice guidance for colour in digital textile printing

[54] Tauba Auerbach RGB Colorspace depicts every colour imaginable https://www.thisiscolossal.com/2012/09/tauba-auerbachs-rgb-colorspace-atlas-depicts-every-color-imaginable/

[55] Le Corbusier https://digitaltextileprintingblog.wordpress.com/2017/09/29/practitioner-le-corbusier/
Colour keyboard based on noble range of colours (white, black, ultramarine blue, blue, English green, yellow ochre, natural sienna earth, vermillion, carmine, English red, burnt sienna earth)

[56] Ann Veronica Janssen https://digitaltextileprintingblog.wordpress.com/2016/12/14/practitioner-ann-veronica-janssens/

[57] Olafur Eliasson https://olafureliasson.net/archive/artwork/WEK100285/your-atmospheric-colour-atlas

[58] Email correspondence with Provost 04/07/2017

[59] Design software, such as Adobe Photoshop, have a set of pre-defined profiles, representative of generic colour spaces, which can easily be applied to an image. Profiles can be shared electronically either for example from a Digital Print Bureau, or within a supply chain with low to little cost.

[60] This was further corroborated by industry experts. Duncan Neil at Earthed Fabrics spoke about his 'biggest bugbear' being light to mid greys and creams (Appendix F p28)

[61] Hue, Brightness and Saturation values were observed to decrease for mapped colours.

[62] Duncan Neil had problems with darks, greys, and pale colours
Emma Kendall had problems with teal blues, navy, and purples

Designer Consultant A had problems with blacks, greens, oranges, and magentas

Made in Brighton had problems with pink, black, red, and pastel shades. The colourant set in this print environment included a red dye which presumably enhanced the range of reds that were replicable.

[63] http://colourmimix.co.uk/

ColourMimix is a colour tool that uses a visual gamut mapping exercise which is carried out by the user, enabling them to gain knowledge about the screen to print-colour differences for their particular set up. Using a set palette of colours, a tile is printed to gauge the print environment. The user adjusts the colours on screen based on the printed colours. This palette forms the base of all subsequent colour mixing which is done subtractively rather than additively.

[64] The personal circumstances of the researcher during this period were as primary carer for a breastfed infant.

[65] https://digitaltextileprintingblog.wordpress.com/2017/02/12/archive-visit-crysede-penlee-museum-penzance-cornwall/
https://digitaltextileprintingblog.wordpress.com/2017/02/12/archive-crysede-penlee-museum-penzance/

[66] The researcher had worked on a live project with Transport for London generating new designs for bus transport

[67] https://digitaltextileprintingblog.wordpress.com/2018/02/19/archive-visit-transport-for-london-interwar-moquettes/

[68] https://digitaltextileprintingblog.wordpress.com/2018/01/29/archive-visit-eileen-hunter-at-the-clothworkers-study-centre-victoria-and-albert-museum-blythe-house-london/

[69] https://digitaltextileprintingblog.wordpress.com/2017/02/14/exhibition-a-room-of-their-own-lost-bloomsbury-interiors-11th-june-to-4th-september-2016-victoria-art-gallery-bath/

[70] https://digitaltextileprintingblog.wordpress.com/2017/03/01/exhibition-vanessa-bell-1879-1961-dulwich-picture-gallery-8th-february-to-4th-june-2017-london/

[71] http://digitaltextilecolour.org/digital-textile-colour-a-research-toolkit/about-digital-textile-printing/

[72] http://digitaltextilecolour.org/digital-textile-colour-a-research-toolkit/research/colour-conversations/

[73] http://digitaltextilecolour.org/digital-textile-colour-a-research-toolkit/research/methods/

[74] http://digitaltextilecolour.org/digital-textile-colour-a-research-toolkit/colour-archive/

[75] For example Adobe's out-of-gamut warning tool

[76] http://digitaltextilecolour.org/digital-textile-colour-a-research-toolkit/about-digital-textile-printing/

[77] http://digitaltextilecolour.org/digital-textile-colour-a-research-toolkit/research/experimental/

http://digitaltextilecolour.org/digital-textile-colour-a-research-toolkit/research/methods/

[78] http://digitaltextilecolour.org/resources-reading-list/

[79] https://www.tandfonline.com/doi/full/10.1080/20511787.2020.1827802

[80] Material was examined by key industry organisations including SDC, ASBCI, TI and UKFT as well as Appendix F – Questionnaires with HEIs (Society of Dyers and Colourists, 2008; Association of Suppliers to the British Clothing Industry, 2014b, 2014a)

[81] The inquiry was able to find two Praxis explorations specifically about colour in DTP. These were Leak (1998) PhD and Carden's 2015 book Digital Textiles which refers to praxis experiments.

[82] With two periods of suspension including a one-year maternity leave and further COVID suspension

Appendix A
Glossary

This Appendix provides an explanation for a number of terms used in the research project

Additive Colour System	The Additive system is intangible colour. It is the process of mixing coloured light. The Additive colour system is represented by the Light colour wheel. There are three primaries, red, green and blue which when combined create a range of colours. When they are combined equally they produce white. Additive colour mixing is how we perceive colour on screen. The additive colour wheel is the light wheel in that it represent the primary colour of light (green, red and blue) and the colours that they go on to create. The additive colour wheel is representative of colour creation in that it accounts for the spectral colours of light. The wheel is divided into six sections with three light primaries (red, green and blue) and the three secondaries (yellow, magenta and cyan) that the light primaries make up. The secondary colours are reflective of the primary colours of the subtractive colour wheel and are the same primary colours that a printer uses to make up colour in digital printing. Additive colour creation is how we see colour on our TV, computer and mobile phone screens.
Adobe RGB 1998	Adobe RGB is also an output colour space and virtual device profile, developed to encompass most achievable colours through CMYK mixing and created by Adobe. It is a very large colour space and attempts to support conversion issues between RGB and CMYK by accommodating as many colours from the CMYK range that can be reproduced on a computer screen using additive mixing. Adobe RGB 1998 was designed to represent most of the colours reproducible in photographic film. The colour range encompasses saturated, bright colours making images appear vivid.

Aniline dye	Aniline Dyes were invented by William Perkin (1838-1907). They are the first synthetic dye. Chemists increased the number of new synthetic colours to meet demand. Synthetic dyes were popular because they were cheaper, colourfast and offered a broader range of colours.
Adobe photoshop (APCC)	Adobe Photoshop was originally developed to support the photographic industry with editing digital artwork. Many of the tools are derived from analogue processes such as applying a filter, and focus on tools which alter tonal contrast. It has evolved into a popular design software used by a variety of disciplines with additional tools and plug ins to meet the needs of multiple users. APCC stands for Adobe Photoshop Creative Cloud, the version of the software used for the inquiry.
AVACADCAM	AVA CAD CAM is a textile design software for surface design industry in particular wallpaper, fashion and ceramics. Additionally it provides Raster Image Processing Software and Colour Management Software AVA is a textile design tool It specialises with in real time repeats, colourways, and has integrated colour management.
Balance	The balance of an artwork refers to the overall distribution in terms of composition, colour and tone. Colour balance in particular refers to the intensity of the colours.
Bauhaus	The Bauhaus (1925-1932) was a school training artists for industry in Germany. Despite its short existence it has been highly influential on design education and culture and many students and tutors went on to have prominent careers.
Bespoke Customisation	A method of altering a product so that it is particular to the customer purchasing it. For example a t-shirt printed with photographs selected and uploaded by the customer
Bezold effect	An optical illusion, where a colour may appear different depending on its relation to adjacent colours.
Brightness	Brightness refers to the colourfulness of a colour. A hue's brightness is decreased by mixing other hues and black white and grey to it.
Chroma	Chroma is the Greek word for colour and is a measurement of colour purity in the Munsell system relating to colourfulness relative to brightness

Commission International d'Eclairage - International Commission on Illumination (CIE)	The *Commission International d'Eclairage* - International Commission on Illumination *(CIE)* was established in 1913 and operates as an international, industry standardisation body to establish colorimetric specifications. It has developed several colour spaces that mathematically map human vision under defined observation standards. The spaces are derived from the additive mixing model and use tristimulus values and colour opponency theory.
CIE LAB	In 1976 CIELAB was introduced as a device independent and perceptual space to document colour differences. L represents lightness, A red-green and B yellow-blue. The LAB system translated the original *xyz* values that correspond to tristimulus values, into lightness (L) and colour-opponent dimensions (a – green to magenta, b blue to yellow). CIE LAB represents a colour space for the human perception of coloured surfaces and dyes. CIE LUV offers a colour space for coloured displays
CMYK Colour Model	The CMYK Colour Model refers to cyan, magenta, yellow and black colorants and is derived from subtractive colour mixing. A CMYK colour space will be determined by the colorants used, plus the substrate. Although the model has four primaries, conversely it produces a small colour space than RGB. This is because the fourth colorant, black, is included to darken rather than increasing the number of colours available by mixing. As CMYK colour spaces are used primarily for printing, the substrate, in most cases white, must also be considered a primary. Printing methods also contribute to the smaller gamut. Most print environments will use colour spaces derived from the CMYK colour model. CMYK printing is subtractive in that the CMY colorants subtract red, green and blue wavelengths i.e., cyan absorbs red, magenta absorbs green, yellow absorbs blue creating the perception of a full colour image.

Colorant	Colorants are colouring agents such as dyes and inks which can be used to alter the natural colour of a medium. Colorants can be classified as dyes, organic compound molecules dissolved in water or an organic solvent, or inks (pigments), non-organic particles in a suspension. Textile colorants are water-based and are mixed with a binder. The part of the colorant that produces the colour is called a chromophores. The purity of colorants is determined by cost, stability and multiple end use requisites meaning quality may be compromised impacting colour outcome.
Colorimetry	Colorimetry is a scientific technique for colour measuring. It assesses colour through objective quantification
Colour	Colour is a general term used to describe a hue or white, black and grey, and further tints. Colour is a sensation, arising from stimulation of the visual system by light wavelengths, interpreted by the brain as the perception of colour. Yet colour is not a physical property, rather it is an ephemeral, optical response to the transmission of light. To be able to perceive colour, there must be an illuminant and a surface. When light is emitted it fragments upon meeting a medium. A detector, for example the human eye, subsequently senses the reflected light and registers this as colour. Therefore colour might principally be considered a visual property of light. Equally, colour might be considered the property of objects. An object may have a natural colour or be coloured using organic and non-organic compounds. Colour is a useful tool. It creates impact and desirability. It has been used by humans to communicate with, aid organisation, and as a means of decoration and playfulness. Colour plays an important role in social, cultural and economic activities. Colour might therefore simply be categorised as tangible and intangible colour. This seemingly simultaneous oppositional existence is further complicated because perception is also dependent on context.

Colour rendition chart	Colour rendition charts were created as visual evaluation tools for the photographic, television and printing industries. They are made up of a set of essential colours- based on RGB and CMYK primaries, and colours that are challenging to reproduce.
Colour constancy	Ensuring that a colour or look of an artwork remains unchanged every time it is recreated
Colour fidelity	The accuracy or faithfulness of the conversion of a colour from one colour space to another
Colour forecasting	Colour forecasting dates back to the 1930s when mass production and ready-mades increased and bespoke services, which were expensive, consequently reduced. In order for manufacturers to understand the market and make products which would be profitable, agencies provided analysis information forecasting consumer's requirements. This includes information about colour trends. Trend prediction is a massive component of the textile industry with a number of focused, specialist markets and components. Agencies sell information predicting future seasonal styles which designers interpret. This can lead to trend prediction influencing fashion, although there are some designers who work to their own personal style. The Pantone© Colour Institute and Colour Index International, published by Society of Dyers and Colourists in collaboration with the American Association of Textile Chemists and Colorists , both produce comprehensive reports about colour manufacture for ranges of materials including paints, textiles, inks and plastics.
Colour harmony	Colour harmony is the relationship between colours. It can also be used to describe visually pleasing combination of colours in a design.
Colour Management	Colour Management is the process of understanding device behaviour in order to control colour as it is converted. The aim to produce a pleasing image rather than a colorimetric accurate one. It can be broken down into three categories; calibration, characterization and conversion.

	In colour management you have to define your colour by gathering data from the devices being controlled. For example using a colour measurement device to obtain information about how a device outputs colour. This colour is then normalized – converting data in to a common colour space for example CIE LAB. The input colour is then converted to the output colour space. Finally a proofing process will be undertaken to assess accuracy. Colour management is not able to account for the impact of lighting and viewing conditions or psychological factors on colour perception
Colour Measurement	Colour measurement uses devices such as a spectrophotometer to gather data about an object's perceived colour. Colour measurement in textiles has been a standard of best practice since its early adoption by Marks and Spencer in the 1980s with an established British Standard for the colour measurement of textiles (SDC BS 8475:2006). However this doesn't yet include standards or procedures for measuring digitally printed fabrics.
Colour Model	Colour models are general, systematic methods for colour organisation. They differ to colour systems, and their visual representations, colour wheels, in that they specify precise values which correspond to a particular hue. It can be helpful to envisage colour models as particular principles which are derived from the theoretical design of colour systems. Colour models are based upon phenomenological research or, additive/subtractive colour mixing. They provide the blueprints which can be used to create a particular colour space, similar to a method and an example.

Colour Phenomena	Colour phenomena are idiosyncrasies, unusual occurrences related to colour perception. Examples are after image and the colour contrast laws as well as metamerism and the Bezold effect. Artists and designers have frequently exploited these colour tricks.
Colour picker tool	A design software tool used to select and assign colour
Colour Space	Colour spaces are systematic methods for colour organization based on colour models. They can have a number of types, related to purpose; perceptual, interchangeable (device independent), selection, input / output, colorimetric and colour difference. A single colour space might intersect several types. For example the CIE colour spaces are interchangeable and colorimetric and may be used to establish colour differences. A perceptual colour space considers the attributes of colour (hue, lightness and intensity) for example HSB. Input / output colour spaces are derived from the RGB or CMYK colour models and are device dependent. These systems are useful because they can be used to specify and identify colours, and demonstrate relationships.
Colour standards	Colour standards are used as part of colour communication best practice. They are a set of samples which can be used to communicate colour within the colour supply chain. Normally physical, standards should also include digital spectral reflectance data, a 'digital colour finger print'. Increasingly the digital data and record keeping is used for final approval. In some cases they may be made up as a bespoke collection of colours made by an independent lab or a commercial purchase, for example from Pantone□. Standards are affected by environmental conditions and should be kept accordingly and under the same conditions as others in the chain. Colour standards need to meet colour consistency requirements such as metamerism and need to be at least 4cm by 4 cm to

	reduce colour influence. It is recommended that a piece of grey card is placed around the sample or used as a view finder to reduce environmental influence Colour standards have to meet 0.5 and 0.3 DE colour tolerance using the CMC 2:1 formula
Colour System	Colour systems describe the different ways in which colour mixing might happen. They have evolved over time through established colour principles. There are three colour systems and an understanding of each is required to explain the issue of screen to print colour outcome. These are the additive, subtractive and, to a lesser extent for this particular problem, the partitive colour system. The additive system describes how a computer screen is able to reproduce colour and the subtractive system describes how we perceive a digitally printed textile to be full colour. The partitive system describes how our visual perception can be influenced altering our colour perception. Each system can be represented by a colour wheel. Colour wheels are diagrams which show the different combinations of primary, secondary and tertiary colours needed to mix colour. Like colour systems, colour wheels do not give the exact values required to mix colours, rather they show the proportions and combinations of hues.
Colour target	A colour target is a set of colour swatches which range in number depending on the software used and user selection. The target is measured, and the returned data is used to provide an overview of colour options for the look up table, limiting the amount of data to be stored
Colour theory	A set of principles and laws derived from the study of colour
Colour wheel	Colour wheels are diagrams which show the different combinations of primary, secondary and tertiary colours needed to mix colour. Like colour systems, colour wheels do not give the exact values required to mix colours, but the proportions and combinations of hues.
Complementary colour	Relating to colour harmony Colour systems have established that there are complementary colours or opposite colours. These

	colours have a special relationship in that they enhance each other. - Subtractive complementary - Optical complementary - After image complementary For example the complementary colours of the primary colours of the additive colour system are the primary colours of the subtractive colour system. These are placed in opposition to each other in a colour wheel diagram.
Concept to Consumer	Concept to consumer is a quick manufacturing response where products are manufactured in a short time frame in order to meet consumer's needs / desires
Continuous Tone	Where colour mixing is created through solid colorant application. There is no need for a dot matrix to give full colour perception. Dye Sublimation is continuous tone. Continuous tone in inkjet printing is very expensive because it uses more ink.
Contrast laws	A set of colour contrast laws that outline the influence of the environment on colour perception. They are a type of colour phenomena Successive contrast - also known as 'After Image' – When you stare at one colour and then look away and the complementary colour appears in your vision Simultaneous contrast – The human visual system requires the complementary colour to be present to be able to perceive colour. If it is not there the brain will automatically generate it. successive and simultaneous contrast suggest that the human eye is satisfied, or in equilibrium, only when the complementary relation is established Itten lists the 7 contrast laws as 1. contrast of hue 2. light dark contrast 3. cold warm contrast 4. complementary contrast 5. simultaneous contrast 6. contrast of saturation

	7. contrast of extension
Digital	Any technology or process that uses binary digits (expressed as 0s and 1s) to alter a state or compel a function of the device they are applied to. This change could simply be on or off.
Digital Inkjet Textile Printing	Digital Inkjet Textile Printing creates a print in a single pass, unlike traditional screen or rotary prints which prints colour in layers. The print head travels across the fabric depositing cyan, magenta, yellow and black colourant in a matrix of tiny dots to produce, what is perceived as a full colour print. Equally sized dots of colorant are jetted in a concentrated, matrix pattern known as dithering, giving the illusion of full colour
Digital Print Bureau (DPB)	Digital Print bureaus are commercial printers and undertake the outsourced process of printing the fabric. They are the producers of most digitally printed fabric. They are primarily located in urban environments speeding up textile production to retailer.
Digital Textile Printing (DTP)	Digital textile printing refers to any textile printing mechanism which is operated by binary data. In modern times this will mean production methods that are computer operated. But also includes Jacquard looms from the industrial revolution which were operated by punch cards. Types of digital textile printing includes inkjet, dye-sublimation, garment printing, latex and UV.
Dithering	A dither is the placement of dots in a matrix to produce the optical illusion of full colour perception. There are different types of dither, produced using an algorithm which will vary the placing of the dots to be either equally spaced, known as half toning, or varied, known as diffusion or stochastic screening. This technique was developed by Frederick E Ives (1856-1937) for photographic printing and furthered by Hans Neugebauer(1901-1987).
Drop on Demand	Drop on demand is the primary method used in digital inkjet textile printing where drops of colorant are

	generated only when needed according to a dither algorithm. This differs to continuous tone printing where colorant is continuously ejected, for example dye sublimation printing.
Drop Shipping	Drop shipping is a business model where stock is only purchased by the retailer once an order has been placed by the consumer. Stock may be purchased from a third-party or commissioned at point of sale. It is useful for online businesses who ship the product to the consumer and do not wish to carry stock.
Dye Sublimation	Dye sublimation uses sublimation inks, also known as disperse dyes. Due to the heat required synthetic or synthetic mixed fabrics are used, printed directly or indirectly using a special heat transfer paper which is then applied to the final substrate. The largest market for dye sublimation printing in the textile industry is soft signage and flags although many fashion fabrics and more recently interior fabrics are printed using this method. Indirect dye sublimation is more prevalent because direct printing is more expensive and quality inconsistent. Fabric printed directly requires pre-treatment, similar to inkjet printing, increasing cost but the dye penetration is deeper meaning that a desired pattern show-through occurs on the other side of the fabric which is beneficial for printing scarves. . Indirect dye sublimation is more prevalent because direct printing is more expensive and quality inconsistent. Fabric printed directly requires pre-treatment, similar to inkjet printing, increasing cost but the dye penetration is deeper meaning that a desired pattern show-through occurs on the other side of the fabric which is beneficial for printing scarves.
Dyes	Dyes are organic compound molecules dissolved in water or an organic solvent. Dyes have a superior colour range And as they are soluble are more suitable to ink jet printing because they can be jetted through the print head. Dyes can are divided into different types dependent on their suitability for the intended fabric and end use.

	Dyes can be natural or synthetic. DTP primarily uses disperse (sublimation inks) and reactive dyes but acid and direct dyes as well as pigments and latex inks may be used. Recently there has been development with introducing VAT dyes.
Entrepreneurial business models	Entrepreneurial Business Models are those which show initiative and resourcefulness and take risks in order to develop as a company
Fugitive colour	A tertiary colour that occurs when two colours overlap in print making.
Gamut and Gamut Mapping	A Colour gamut expresses the range of colours of a device. It is limited by the most saturated colours that the device has to work with (i.e. primaries). The dynamic range is limit of brightness (or tonal information) whereas the gamut represents the boundaries of the colour space. Gamut mapping is the conversion of colours from one space to another For example the screen to the printer. As colour spaces may overlap but are not perfect copies there will be compromises made about colour conversion which can impact the overall outcome. Leak cites MacDonald with 5 potential approaches gamut mapping known as rendering intents. Do nothing — The device clips each signal to its maximum value Truncate — Colour replaced by nearest value on gamut boundary Umbrella — Linear scaling of all colours to fit inside gamut Non-linear — Scale colours near boundary more than those inside Image dependent — Let the user adjust controls to achieve best result See also rendering intents
Half Tone	Half tone is a type of dither. It is where the dots are equally spaced. Stochastic screening or diffusion dither is where the placement is varied.
HSB Colour Space	The HSB colour space is derived from the RGB colour model and is a colorimetric type of colour space.

	It uses the attributes of hue, saturation and brightness mimic the properties of human perception and feel instinctive. Hue is adjusted by varying the RGB concentration, Saturation can be increased or decreased by adjusting the concentration of the complementary hue, and Brightness is adjusted by scaling up or down all concentrations equally. Studies have shown that HSB spaces are user accessible and increase colour accuracy.
Hue	The hue is the colour family name. For example red, yellow, blue. Black, white and grey are not hues.
International Colour Consortium (ICC)	International Colour Consortium was established in 1983 by a group of businesses working in computing to create and promote colour management standardisation across colour management.
ICC Profile	As a result ICC profiles were developed and can be used universally across different software and devices, storing data in a colour look up table, used for converting colour data.
Illuminant	A source of light. This can be natural i.e. daylight, or constructed for example electric lighting.
Just in Time	Just in Time is a manufacturing model which promotes speed and efficiency above other considerations.
Know-How, Know-What, Know-That	Nelson's model for Practice as Research. Know-How refers to the embodied knowledge of the practitioner-researcher, Know-What refers to the praxical knowledge generated and Know-That, the extended knowledge gathered through a contextual review.
LED LCD screen	LED stands for light emitting diode and LCD stands for liquid crystal display. These refer to the type of screen or monitor that a device will use. They are bright and illuminated and back lit producing bright vivid colours.
Linearization	Linearization uses colour measurement data to ascertain the optimum media (colorant, substrate etc.) settings for use with a particular printing device
Luminosity	Strength of colour, similar to saturation
Metamerism	Metamerism is where an object may be perceived as the same colour as another under one set of conditions, but differs when the conditions alter. This can cause problems in the textile industry where products are sold, and photographed, under bright lighting conditions which differ to daylight or lighting in domestic interiors.

Opponent Theory	This is a colour theory developed by Edwald Hering that states that the human visual system interprets information about colour by processing signals in an antagonistic manner. The theory suggest that there are three opponent channels: red versus green, blue versus yellow and black versus white (the last type is achromatic and detects light-dark variation or luminance).
Pantone©	Pantone© is a colour reference tool used in industry to identify colours throughout the design and production process. It is a selective colour space derived from the CMYK colour model. The system was created by Lawrence Herbert in the 1960s as a means of resolving colour communication issues in graphic arts. Each colour has a six digit reference referring to lightness, hue and saturation. Pantone© uses nine base colours which are mixed to create the range. However it also provides percentages to produce the colour using a CMYK mix. Yet around 20-50% of colours cannot be accurately matched using CMYK ink jet printing due to the print method. A designer might use Pantone© chips or a Pantone©reference number to indicate the intended colour(s) when communicating with a printer, colour lab, manufacturer or buyer. This colour reference provides a match to return to when proofing and trialling samples. Pantone© textile swatches are dyed, rather than printed, using products equivalent to those used industry. As well as the matching system Pantone© provides trend forecasting tools for fashion and interiors.
Practice as Research (PaR)	Practice as Research is a methodology with a 'thinking-doing' approach to research. The practice, or profession, is the heart of the investigation, conducted through the practice and as an outcome and means of disseminating the findings of the inquiry.
Partitive Colour System	The Partitive system represents the change in perception that happens when colours are placed next to each other. It is the process of colour contrast influence or simultaneous contrast, a colour phenomena. The influence of these colour relationships alters the way a colour will be perceived, 'mixing' the colour. The Partitive colour system is represented by the Munsell wheel. It has five prime colours, yellow, red, green, blue and purple. Each of these hues, when looked at intensely, causes a negative after-image, a visual response where

	the complementary colour appears in our vision once your gaze moves to a white surface. Albert Munsell (1858-1918) arranged his wheel so that the primes are opposite their complementary. He was able to develop this diagram into a three-dimensional colour order system arranged to incorporated lightening and darkening of hues which is used as a commercial colour communication tool today. The partitive colour wheel represents the complementary colour relationships. This colour wheel embodies the colour theory that the Neo-Impressionists were using in their Pointillism technique. Munsell developed this partitive colour system based on the concept of afterimage. Afterimage is a reaction by the eye when you've been looking at a particular hue for a long time and then look at a white surface, an afterimage of the complementary colour of the hue you had been looking at will be present in your vision. The colour wheel is divided into twenty sections, much broader than either the subtractive or additive colour wheels. It has five primary colours (yellow, red, violet, blue and green) which are positioned opposite their complementary colours (blue-violet, blue-green, yellow-green, orange, red-violet) and then the tertiary colours they create when mixed.
Pigment	Pigments (inks) are non-organic particles in a suspension. They produce more permanent colour and do not require additional processing for example steaming and washing for fixation in DTP. Pigments suffer from environmental metamerism which creates quality issues particularly for retailers using shop lighting conditions. Pigments can be ground small enough to be used in ink jet printing but frequently clog print heads as they remain solid particles.
Pointillism	Pointillism is an optical mixing technique similar to dithering, and builds colour in a series of dots. It was used by the Neo Impressionists.

Practitioner-Researcher	A practitioner-researcher has a dual role of professional and investigator. They have a skill set in the profession they are working in addition to researching issues in their field.
Praxical and Praxis	The combination of theory and practice, or ideas, in a 'thinking-doing' approach. From Barrett and Bolt and Nelson's models of Practice as Research
Pre-treatment / Coating	Pre-coatings are a treatment in the preparation of fabrics for digital textile printing. Coatings sometimes described as a pad liquor, use basic chemistry adapted from knowledge of the binders and thickeners used in traditional dye and print pastes. The addition of binders and thickeners enhances the resulting print colour quality, as well as providing fixative properties for textile end uses. Different coatings are required for different fibres and further variations needed, depending on colorant (reactive, acid, disperse or pigment ink).
Primary colour	A hue that can not be made from colour mixing.
Print Pass	The number of times a substrate is passed through the printer. In DTP this is normally in one pass, i.e. a single instance.
Print-Colour	The perception of colour created by a printer using colorants, dyes or pigment inks. In DTP the colorants are cyan, magenta, yellow and black and built up using tiny dots placed in a matrix to give the perception of full colour. The colorant set can be extended to included red, blue, grey, orange and green as well as light versions of cyan, magenta and grey in order to expand the range of possible colours although not gamut. Print colour is subtractive.
Profiling	Profiling is a means of comparing measured reflectance data, from RGB (red, green and blue) or CMYK colour ranges, produced by a particular device or devices, with known or defined reflectance data from colour models. Data is stored in a look up table, used for mapping an input to an output value to provide information about numerous colour possibilities. Profile maker software uses a colour target as a means of gathering information about the device's colour reproduction. A colour target is a set of colour swatches which range in number depending on the software used and user selection. The target is measured, and the returned data is used to

	provide an overview of colour options for the look up table, limiting the amount of data to be stored. Colour Management processes such as profiling have been developed to maximise a device's achievable gamut. These processes use data from the print environment to optimise the print outcome. A profile aids conversions between RGB pixels of light and solid CMYK dots of colorant. Many screen profiles provide a false idea of colour reproduction possibilities as their gamut boundaries are far wider than the colours achievable using CMYK colorants.
Purity	An unmixed hue. One that contains no black, white, grey of complementary hue.
Rendering intents – perceptual etc	Rendering intent are the methods applied in gamut mapping, the conversion of colour data from one colour space to another. Converting pixels of light on screen to printed dots of colour involves considerable modifications. A rendering intent will prioritize certain colour qualities over others, depending on the desired image outcome. For example, a perceptual rendering intent is used to obtain an equivalent colour balance in the output image to the input image. A uniform gamut compression is applied to the entire input colour range, maintaining colour relationships, and preserving lightness and saturation. This is useful for printing photographs where light and tone will be important. In contrast, a relative colorimetric rendering intent will prioritize out-of-gamut colours, shifting these to the closest in-gamut hue from the output colour range. Colours that are in-gamut remain the same. However, there is the potential for a loss of overall tonal quality as out-of-gamut colours are mapped to similar hues as in-gamut colours. This method is useful for proofing because gamut mismatches become clearer allowing amendments to be made to the original design. Rendering intents have been developed for enhancing prints on paper and subsequently do not account for textile substrates. Additionally, there is a lack of industry standardisation around the selection of rendering intents. It is likely that a designer will not even be aware of the rendering intent used by the DPB nor their purpose and impact on colour outcome.

	It can be undertaken in different ways depending on the desired outcome. Perceptual (Picture) recommended for maintaining the same overall relative colour rendering balance Relative colorimetric (Proof) converts only out of gamut colours preserving lightness but not saturation Absolute colorimetric (Match) converts only out of gamut colours to the nearest hue but sacrifices saturation and lightness Saturation (Graphic) maps the saturated primary colours in the sources to those in the destination irrespective of differences in hue, saturation, or lightness. Dawson in Ujiie 2006
RGB Colour Model	RGB stands for red, green and blue and is an additive mixing colour model. Colour display hardware such as computer monitors or televisions use colour spaces derived from the RGB colour model to determine the proportions of red, green or blue light required to reproduce colour on screens. Every screen's achievable gamut will be different due to age, temperature, make, model, and viewing conditions. A computer reproduces colour by assigning code to three channels, red, green and blue. These are subdivided into 256 levels of tone which uses up 8 bits, or 1 byte of storage. This creates the possibility of 16.8 million colours, or 256 x 256 x 256.
Raster Image Processor (RIP).	This is used to communicate between a device and the printer. It performs a conversion of postscript data, to the dots used by the printer to represent an image. Some RIPs also handle colour management and conversion processes to increase the printing speed and, similarly to profiling, linearization and calibration, were devised for reprographic and photographic industry printing. There are a number of specialist RIPs for DTP with algorithms which focus upon achieving seamless pattern repeats, motif scaling and colour ways, as well as handling specialist spot colours required by the textile industry. Information about the textile chemistry such as pre-coating and fixation methods are not normally incorporated although they may be able to incorporate shrinkage information and compensate by scaling the image accordingly. The RIP will be part of the print

	process operated by the DPB and not normally accessible to the designer. However, a designer should request information about the RIP a DPB is using as knowing whether they are using a specialist textile RIP will aid a designer's choice of DPB
Rods and cones	These are photoreceptors in the eye and part of the human visual system, They generate electrical signals from the transmission of light. These signals are delivered to the brain The eye three cones which provide photopic vision. Rods which are light sensitive only do not play a role in colour vision. They are used in periods of low light, known as scoptic vision.
Saturation	The colourfulness of a hue relative to its purity. Saturation is decreased by the addition of white only.
Screen-Colour	The perception of colour created by a luminous screen using pixels of red, green and blue light. These can be dimmed or brightened to create tone. Screens use a range of illuminants to create colour including LED (light emitting diodes) or LCD (liquid crystal display). Screen colour is additive
Secondary Processes	After print processes applied to a digitally printed fabric such as steaming and washing
Spectrophotometer	A spectrodensitometer will return sophisticated colour measurements using filters to measure the wavelengths reflected from the colour sample
sRGB IEC61966-2.1	sRGB IEC61966-2.1 is an output device colour space and virtual device ICC profile developed by Hewlett Packard and Microsoft. It represents the colours that the average computer monitor screen is capable of reproducing and is applied as a ICC profile, a post script for storing colour dat.
Substrate	The base cloth or surface that the print is made upon. In DTP this can be made from natural fibres or a synthetic-natural mix or fully synthetic.
Subtractive Colour System	The Subtractive system is tangible colour. It is the process of mixing colorants. The Subtractive colour system is represented by the Pigment colour wheel and the Process colour wheel. The Pigment colour wheel has three primaries, red, yellow and blue which when blended can mix a range of

	other colours. A pigment is a colorant, a material that colours something, by changing the way it reflects or absorbs light. This method is used to teach colour mixing in creative education. The Process colour wheel has cyan, magenta and yellow primaries and is associated with the process of print making because it is the method used in CMYK printing to create the perception of a full colour image. It has a larger range of reproduceable colours than red, blue and yellow, but is less renown. When each set of primaries are combined equally, they create a darker hue, close to black. The subtractive colour wheel is the pigment wheel, sometimes called the artist's colour wheel, in that it represents the primary colours of pigments (yellow, red and blue) and the colours that they go on to create. A pigment is a colourant, a material that colours something, for example a dye, by changing the way it reflects or absorbs light. The wheel that is divided into 12 colour sections, the three primaries (red, yellow and blue), then the three secondaries (green, orange and violet) and six tertiaries (yellow-orange, red-orange, red-violet, blue-violet, blue-green, yellow-green) that these three primaries make up.
Textile designer	A textile designer is the person who has creative input into artwork to be manufactured into a textile. This may include print design, knit, embroidery or weave. They will need to confidently assess a design's commercial possibilities and be innovative. Typically a designer will work to a brief, drafting initial sketches, colour palettes and tactile ideas. Textile designers will be required to have specific knowledge and skills which enable them to comprehend the manufacturing and production requirements, in particular the end use of the fabric.

	Textile designers may work in a variety of areas including engineering, architecture, chemistry and creative industries. Some designers are employed as part of a company or design studio others work as freelancers and may be represented by an agent. Some designers will oversee from design to product, others produce the design which is then taken into production by someone else.
Tone	The tone refers to the addition of grey to a pure hue to make it duller. Tonality will refer to the overall composition of an artwork and whether the steps between different tones of a hue are small or large which impact the overall colour balance.
Trichromatic theory	The human visual system has three cones which provide photopic vision, known as trichromatic theory. The theory was developed by Thomas Young (1773-1829) from a hypothesis made by George Palmer (1746-1826), proposing that the eye had three nerve fibres corresponding to red, green and blue. Later, Herman von Helmholtz (1821-1894) identified that these are receptive to short, medium and long wavelengths. The cones interact providing the sensation of colour which is interpreted by the brain, producing colour vision Trichromatic theory was supported by the work of James Clerk Maxwell (1831-1879) who demonstrated that these three additive primaries were capable of mixing all other perceived colours (1860). His work became the basis of colorimetry, a scientific technique for colour measuring.
Value	The value of a colour refers to the lightness or darkness relative to the pure hue. A tint is where black or white is added.
Vector and raster image	Computers depict images on screen either by defining a set of mathematical points as drawing instructions (vector files) or using tiny dots, pixels, to make up an image. Vector images can be scaled up or down easily whereas pixel images have dependent on the dots per inch (really pixels per inch but an example of analogue printing term used for digital technology).

	Photoshop uses pixels and examples of pixel file formats are jpeg, tiff and gifs. Examples of vector images are ai and eps files. However, as printers use dots any vector image has to be converted or rasterized into pixels in order to be understood by the printer. Pixels of RGB light have varying levels of density and intensities unlike dots of colorant that cannot vary in density or size.
Wavelength	Light is a distribution of wavelengths, sometimes observed as a stream of particles. The wavelengths are divided into a range called a spectrum, consisting of seven hues, which correspond to the colours of the rainbow. The spectrum represents pure hues and lacks achromatic colours such as black, white, grey, brown and skin tones which are perceived through a combination of wavelengths. Wavelengths are measured in nanometres (nm). They travel at different speeds and are different lengths.

Appendix B
Methodology Terms and Descriptors

This appendix defines the methods, with examples of usage, outlined in Chapter Two, Methodology.
It also presents documentation of each research activity in relation to Nelson's multi-mode epistemological model – Know-How, Know-What, Know-That

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Definition of Methods

Praxis

Praxis describes a method of purposeful creative investigation through making to generate knowledge. Examples include theory testing, process comprehension, content generation, hypothesis testing, and as a mechanism for articulating research findings (Gray and Malins, 2004). Research Practice differs from Professional Practice in that it must be verifiable, and relate to the stated research paradigm and articulate the new knowledge generated. This may require supporting documentation in the form of sketchbooks, photographs, reflective blogs, as well as complementary writing. (Nelson 2013).

Examples of praxis methods in this research include printing and measuring a set of colour references, creating and studying a design portfolio to assess colour fidelity and testing variables in a print environment to determine their impact on colour outcome.

Observation

The observation method uses perception to evaluate activity to glean information. It is helpful for articulating the mode of Know-What knowledge. It may take the form of looking, touching, comparing and familiarising. It may be recorded through annotation in a document, notebook, sketchbook or reflective journal/blog. (Gray and Malins, 2004)

Examples of observation in this research project include comparing colour differences of print work, annotating print tests and looking at colour changes on screen after software adjustments are made. In many instances, the information gained through the observation determined the development of the research.

This report details the following categories of observation

- Visual Observation - a form of direct observation by looking
- General Direct Observation - assessment through perception
- Indirect Observation – analysis of narrative materials (text and audio)

Visualisation
The visualisation method is to illustrate ideas and thought processes through diagrams, mind maps, sketches, graphs and images. (Gray and Malins, 2004) Examples of visualisation methods used include Colour Maps depicting the hue, saturation and brightness differences between printed swatches and screen colour, mind maps to plan the website tool kit and documenting research progress on Instagram.
Audio Reflection
Audio reflection is a method for articulating internal dialogues when contemplating praxical activities and reviewing progress. Examples of this method include the researcher recording herself on voice notes on her mobile phone and on Dictaphone.
Sketchbook
In this context, sketchbook encompasses traditional and digital mediums for recording ideas, combining visual and textual elements, including documentation of the evolution of ideas and used a lot by designers for isiable design solutions (Gray and Malins, 2004) Examples of sketchbook work include annotations of fabric prints, note-taking during technical instruction, brainstorming and digital sketches.
Reflective Journal
A reflective journal is a method of documenting, reflecting upon, and evaluating research activities. In contrast to a sketchbook, a reflective journal is purposefully designed to chronicle a specific activity. Examples of this method from this research include recording archive visits with key words and mindmaps
Reflective Blog
This report makes a distinction between Reflective Journal and Reflective Blog because the blog is a published document and accessible to others for reading. The Reflective Blog documents the progress of the project by describing activities, presenting and considering research context, and logging dissemination activities. The Research Blog was used to categorise data with meta tags and a public engagement tool. Examples include blogging about practitioners whose work was pertinent to the inquiry, publishing conference posters and papers and creating search groups such as ‘interwar design history’ to access information quickly and easily.

Quantitative Data Gathering and Assessment

Provides measurable assessment of generated numerical data. Examples of quantitative data analysis in this project are the calculation of average differences of colour data using Microsoft Excel and computational analysis of colour data visualised as histograms, these can be seen in experiments involving the Colour Reference Book and Digital Lab Dip Tests and Colour Maps

Historical Archival Research

Reviewing physical and digital records and sources stored in a special collection library or repository, such as physical objects, documents and audio and video recordings.

Examples of archival research in this project include visits to the Victoria and Albert Museum Archive to view and photograph the Eileen Hunter Textile Collection, visiting the Penlee Museum in Penzance to view and photograph the Crysede Collection and accessing the Warner Textile Archive digitally.

Case Study

The qualitative research method of the presenting an example, or single instance, of research activity as a Case Study is used to emphasise a particular narrative or position. (Gray and Malins, 2004)

Example of Case Studies in this report are the Interwar Design History Case Study and a series of Colour Conversations.

Interview

Qualitative research methods are important when interviewing. It is an informal interactive and dynamic exchange – described here as a Colour Conversation - to establish the standpoint of the interviewee (Gray and Malins, 2004). Interviews may take place face-to-face or remotely and recorded (note-taking, audio recording) and ethical considerations were taken.

- Transcription - A subcategory method in this report. Transcription is the technique of listening to a recording of an interview and writing it down.

Examples of interviews in this project are in the Colour Conversation series which were audio recorded and transcribed. Each transcription includes a summary highlighting key points and relates them back to themes identified from analysing the series.

Questionnaire

A method of surveying to collect information about a specific subject or perspective (Gray and Malins, 2004).

Examples of questionnaires in this project are in the Colour Conversation series.

Questionnaires were used when it was not possible to obtain an interview; for instance with print technicians at HEIs whose full schedules did not allow them time to speak on the phone.

Analysis Methods

- Reflective

The critical examination and evaluation of the praxis, the researcher's choices, and praxis outcomes. Reflection was made on decision-making, techniques, concepts, challenges, and achievements in order to gain insights and refine the praxis. Notes were made in sketchbooks, using audio and in conversation with peers.

- Visual

The specific exanimation of visual elements of the praxis, in particular examining the colour changes for example between two different substrate types or printing methods.

- Discourse

The analysis of interview transcripts considering themes and content to uncover the participant's experiences.

- Comparative

The comparison of sources, in the case of the inquiry interview transcripts and content of historical archives to uncover patterns, themes, variations and alternate perspectives to gain a deeper understanding of trends, experiences and colour use.

- Peer Review

Outsider evaluation and feedback on research activities. This took the form of supervisory meetings, critiques with peers from 3D3 Research Cohort, presentations at UWE PhD workshops, presentations at UWE Research celebrations, conversations, and discussions with industry experts.

Research Activities in relation to Nelson's epistemological modes of knowing

Definitions of Terms

Timeline

When was this piece of work undertaken during the course of the Research Project and Doctoral Study?

Intellectual Rigour

What knowledge was generated by this work? How does it meet the project's aims and objectives? How does the work relate to the research problem and / or questions?

Know What '*The tacit made explicit through critical reflection' Know What Works*

How was the work critiqued?

- **Critical Reflection**
  What considerations occurred during the process? How was the work evaluated?

What were the methods and tools used?

- **Methods & Tools**
  Which research structures informed the process? Which tools supported the work? Why were these means chosen?

Know How *''Insider' close-up knowing'*

What is the tacit knowledge that underpins the work? Identify the thinking-doing. Ability and Acquaintance

Know That *''Outsider' distant knowledge'*

What are the principles and concepts that inform this research?

Limitations

What are the weaknesses? How was the investigation restricted?

Colour Reference Book

Description: A bound swatch book of all 1137 Pantone© Solid Uncoated Library Colours digitally printed on four substrates (wool, linen, cotton, silk) and a comparative paper print. A set of colour data (RGB, CMYK, LAB, HSB and #) is recorded next to each set of swatches. The piece was created in the CFPR research studio and Digital Print Centre at UWE, Bristol

Timeline May – Nov 2016 Creation of Book

Jan – May 2017 Measurement of swatches and Data Analysis

Intellectual Rigour

This piece of work establishes that there is a difference between screen-colour and print-colour, evidencing the colour outcome issue. In addition, the work showed that there were further differences in printed colour across fabric substrates, and issues with colour tools; in this case Adobe's out-of-gamut warning tool. It meets Objective 4 'Establish a coherent body of colour work using digital textile printing' and can be considered under the theme 'Colour Expectation' covering RQ1 and 2.

Demonstration of: Gamut Mismatches, Numerous Variables, Adapted Technology

Know What

Critical Reflection

- Visual Observations and Audio Reflection at the end of each step, determining actions for the next stage. Swatches were observed under different light sources (daylight and artificial light) by the researcher.
- External Critique and feedback.
    - A set of swatches were identified and scaled up. These were presented at a 3D3 research workshop where the experiment was critiqued by tutors and peers
    - The work was discussed with supervisory team and members of research centre as well as specialist technicians throughout the process

- Quantitive Data Analysis and Visualisation of the colour data, part of which was in consultation with Dr Paul O'Dowd, an engineering and material science researcher. Visualisations included line graphs and histograms.

Methods & Tools

Methods: The overarching method deployed was Praxis. The praxis work was supported through Observation, Quantative Data Analysis, Photography, a Reflective Blog and Visualisation

Tools: Adobe Photoshop Creative Cloud (APCC), Pantone© Solid Uncoated Library, Mimaki TX2-1600 with reactive dyes, Textile Substrates (Cotton, Wool, Silk, Linen), Spectrophotometer and Microsoft Excel.

Know How

The researcher uses Pantone© and APCC in their professional practice. Her educational background (fine art and design) ensures that she has a comprehensive and creative approach to colour. The researcher has professional experience of the textile industry, and an understanding of the way designers and design studios utilise colour (for example, colour tools, colour communication). The researcher has no known colour vision issues. The researcher has experience and training in visual analysis and reflective research.

Know That

Pantone© Solid Uncoated Library is a broad and comprehensive colour palette ensuring a comprehensive range of hues, and consequently data, could be tested. Pantone© and APCC are widely used by designers and design studios. In utilising these tools, the praxis is testing and observing a real-world scenario.
Additionally, colour swatches and swatch books are a common colour communication tool in the textile and wider design industry.

Separating the colours into swatches rather than considering colour outcome within a design image, avoids the law of Simultaneous Contrast where the placement of adjacent colours will influence how the printed colour is perceived.
Digitally printed colour is created through a dithered matrix of dots of CMYK (cyan, magenta, yellow and black) colorant. This technique was developed in the 1920s as an analogue method and adapted since for digital technology. It is based on the

three-colour print technique discovered by JC Le Blon in 1725 and complementary contrast colour theory as devised by Ogden Rood in 1879.

Limitations

The Society of Dyers and Colourists recommend that swatches are 4cm by 4 cm and backed on grey card for observation. The swatches were printed 2cm by 2 cm and backed on white partly to reduce the print costs but also due to ignorance of the standard recommendation at the time. The swatches offer a singular example rather than a broad range of printers, colorants, and substrates. Only one set of swatches was compiled, and the exercise was not repeated. Therefore, the colour differences may differ if reprinted, or using another print environment. The visual observations were made solely by the researcher and not corroborated.

In addition

This work was exhibited, alongside Digital Lab Dip Test Colour Maps at the Data Ache Conference, Plymouth University, 10-13th September 2017.

Digital Lab Dip Tests / Colour Maps

Description: A set of digitised colour swatches and a corresponding series of colour maps representing Hue Saturation and Brightness shifts between the screen-colour and printed outcomes. The digitised swatches were created by measuring two sets of physical swatches in the Colour Reference Book and recording the LAB data which was entered into Adobe Photoshop to form a digital lab dip test. The work is digital with physical prints of the colour maps for exhibition.

The piece was created in the CFPR research studio at UWE, Bristol

Timeline August-September 2017

Intellectual Rigour

This piece is a culmination of the quantative data analysis and colour measurement work from the Colour Reference Book. It evidences on screen the difference in printed colour across the selected substrates to the original screen Pantone© reference. This screen-to-screen comparison substantiates the colour fidelity issue and provides a tool, the Colour Map, to aid a designer's colour knowledge, allowing resolution of colour issues during the design process. It meets the project's Aim 1 'To develop a tool-kit…' and Objective 4 'Establish a coherent body of colour work using digital textile printing' and can be considered under the theme 'Colour Expectation' covering RQ1 and 2.

Demonstration of: Gamut Mismatches, Numerous Variables, Adapted Technology

Know What

Critical Reflection

- Visual Observations and Audio Reflection by the researcher throughout the design process leading to constant questioning, for example, considering which colour mode was the most appropriate to use when visualising the data.
- External Critique and feedback

- A selection of Colour Maps were exhibited at the Gallery Kopio, University of Lapland in Rovaniemi, Finland until the end of September 2017 and critiqued by tutors and peers from the 3D3 Research Cohort.
- A selection of Colour Maps were exhibited at Data Ache Conference, Plymouth University, 10-13th September 2017 and critiqued by tutors and peers from 3D3 Research Cohort.
- The work was discussed with supervisory team and members of research centre as well as specialist technicians throughout the process.

Methods & Tools

Methods: The overarching method deployed was Praxis. The praxis work was supported through Observation, Quantative Data Analysis, Photography, a Reflective Blog and Visualisation

Tools: APCC, Pantone© Lib and Microsoft Excel. The paper prints were made using a Cannon Pro 6000s Ink-jet Printer.

Know How

The researcher had undertaken an investigation into the history of the colour diagram prior to making this practical experiment which assessed the range of colour diagrams and their uses. Additionally see Know How for Colour Reference Book

Know That

A lab dip is the term for a fabric sample used by the manufacturer to establish a colour match with the buyer's supplied swatch or colour standards.

The use of the HSB colour model allowed simpler average comparisons to be made which were more of a challenge to calculate using the LAB model. The HSB model is closest to a replication of human vision. Human vision observes hue, colourfulness (saturation) and brightness.

Colour Diagrams are useful for visualising colour. Colour theorists historically have differed in their findings and span several fields of research. Therefore, there is a wide range of colour diagrams which are used to visualise colour theories.

The Spectrophotometer was set up to measure the reflectance value under D65 illuminant conditions, the standard for measuring textiles, and return LAB and wavelength (nm) values from 380-730nm.

The HSB model is derived from the colour space of a computer monitor, which uses different intensities of red, green, and blue (RGB) light to realise colour on screen. The hue value represents different concentrations of red, green, and blue light. Saturation changes adjust the intensity of light of the complementary hue altering the vibrance perception. Brightness signifies the change in concentration of the RGB values at the same time. HSB is based on the RGB intensities of the computer colour display monitor. Changes to the Saturation or Brightness value will impact the other.

The CIELAB colour model is the mathematical model of human vision accumulated by tristimulus values, XYZ representing the visible colour spectrum varying by lightness and vividness. The model was published by the CIE in 1931 as a means of defining colour under a set of standardised conditions.

Limitations

The colour measurements, and consequently the data analysed, offer only a single instance of printed colour outcome as the experiment was not repeated. The conversion from the LAB data read by the spectrophotometer to APCC involved a loss of accuracy as APCC uses only whole numbers therefore input data was rounded up or down. It was necessary, to fit the timescale of the project, to reduce the number of Pantone© s to be analysed from 1137 hues to two data sets totally 48.

In addition

A selection of colour maps were exhibited at Bower Ashton Campus, UWE Bristol October – December 2017

Experimental Indicator Profiles

Description: A set of ICC profiles which create experimental and indicator colour changes when applied to an image on screen. The profiles were developed from altered colour targets which were measured using AVA CAD CAM Printer Cal to generate a profile. The targets were altered using data gathered from analysing colour differences between screen and print outcomes in the Colour Reference Book. ICC profiles are used by digital files to convert colour data between devices such as computer screen to printer. The profile translates colours, not found in both devices' colour spaces, to an alternative, dependent on the print environment. The work consists of a set of digital .icc files.

The piece was created in the CFPR research studio and Digital Print Centre at UWE, Bristol.

Timeline June-July 2018 Creation of first set of indicator profiles

March-June 2020 Creation of second set of indicator profiles

Intellectual Rigour

These profiles further contribute to a designer's colour knowledge and understanding of DTP by indicating, on screen-colour changes that may occur when an image is printed, for example onto different fabrics or when using a greyscale palette. Additionally, a further set of experimental profiles were developed to correct colour problems by altering the data using a number of premises established through quantitative data analysis and observation work presenting a solution to the issue. Used as tools, the indicator profiles allow designers to manage expectations of printed colour outcome and correct colour concerns prior to printing. It is recommended that the experimental profiles require further testing in a variety of print environments. This work meets the project's Aim 1 'To develop a tool-kit….' And Objective 4 'Establish a coherent body of colour work using digital textile printing'.

Demonstration of: Gamut Mismatches, Numerous Variables, Adapted Technology

Know What

Critical Reflection

- Visual Observations and Audio Reflection by the researcher throughout the design process
- Visual Observations and Audio Reflection of the indicator profiles when viewed on screen, recorded, and documented to accompany the presentation of the experiment's outcomes.

Methods & Tools

Methods: The overarching method deployed was Praxis. The praxis work was supported using Observation, Quantative Data Analysis, Photography, and a Reflective Blog

Tools: APCC, AVA CAD CAM, Spectrophotometer, Mimaki TX2-1600 with reactive dyes, Textile Substrates (Cotton, Wool, Silk, Linen) and Microsoft Excel.

Know How

The researcher undertook specialist Colour Management training through a skills development placement. This included learning to use a spectrophotometer and profile creation. The researcher received AVA CAD CAM instruction as part of the research project. The researcher uses APCC in their professional practice.

Know That

Colour Management processes such as profiling are used to convert colour data from one device, such as a computer display, to another, for example a printer, to obtain a satisfactory colour match. Profiling is a means of comparing measured reflectance data, from RGB or CMYK colour ranges, produced by a particular device or devices, with known reflectance data from CIE models. Data is stored in a colour look up table, used for converting an input to an output value. Regular profiling is key to maintaining colour accuracy in a print environment. Digital Print Bureaus will build a specific profile to use for each substrate range they print on to attempt to improve colour management data conversions. Designers may apply a profile, provided by their print bureau, to their image file as a means of soft proofing, simulating the printed outcome on screen. Soft proofing is a typical method to assess an image on screen before going to print. Observing colour differences on screen is therefore a common practice for designers who will notice very subtle changes in colour.

The Contextual Review revealed information about how profiles convert colour data as well as experiments by artists such as Professor Carinna Parraman who produced her own profile targets from inks she'd created. Early tests prints made included testing virtual device profiles.

Limitations

The profiles were created within a single print environment and not replicated. The indicator profiles have been tested by the researcher on different monitor displays and within the Interwar Case Study but have not been tested by a user group.

In addition

The indicator profiles were presented as part of a paper given at the Textile Institute World Conference, July 2018 in Leeds, UK (Appendix L)

The indicator profiles were presented as part of a paper given at the AIC Interim Meeting in September 2018, Lisbon, Portugal (Appendix L)

Interwar Case Study

Description: A set of printed designs in a range of colourways and accompanying .ase files representing colour palettes developed through archival and secondary research of Interwar Design in England. Several designs were developed which worked up into different colourways using specifically devised colour palette(s). The designs were printed onto different substrates and the differences observed using the Colour Reference Book and Digital Lab Dip Test - Colour Map methods. Finally, the indicator profiles were applied on screen to the digital image of each design and compared with the prints and reflected upon. The work comprises of two physical swatch books, digital image files, a set of digital .ase files and accompanying text.

The piece was created in the CFPR research studio and Digital Print Centre at UWE, Bristol

Timeline October 2015 – June 2020

Intellectual Rigour

This case study presents a real-world exploration of colour assurance in DTP. It demonstrates the challenges of matching colour from screen to print and then across different substrates. It tested the indicator profiles developed as a key support tool and reflected on the accuracy and usefulness. The Case Study meets Aim 2 'to create an historical digital colour palette which, re-creates colours from the interwar period, as a real-world test scenario' and Objective 4 'Establish a coherent body of colour work using digital textile printing', Objective 5 'Undertake a historical literature survey on the colour palette in the British interwar domestic interior', Objective 6 'Create a historical archive of colour use in the British domestic interior (1918-1939)' and Objective 7 'Test and apply these colours as part of my own practice'.

Know What

Critical Reflection

- Reflective Journal after each archive visit and reflective blog post.
- Visual Observations and Audio Reflection by the researcher through-out the design process.

- Visual Observations through-out the collation of colours for the .ase files including colour selection and recording colour inspiration.
- Visual Observations of the printed designs, annotating the swatch book regarding colour differences and selecting twenty colours to consider further, consequently reduced to fourteen.
- Quantative Data Analysis of differences in colour data between screen and print-colours of the set of fourteen, recorded in a table document. In addition, translation issues between colour data and Pantone© reference was observed and reflected upon.
- Visualisation of screen to print differences for fourteen of the twenty colours, across substrates, were analysed by applying the digital lab dip test and colour maps method. The results were reflected upon and recorded in a table document.
- Visual observations of comparisons of the set of fourteen printed designs on different substrates with screen versions with the indicator profiles applied. Observations were recorded in a table document.

Methods & Tools

Methods: The overarching method deployed was Praxis. The praxis work was supported through the use of Case Study, Archival Research, Direct and Indirect Observation, Praxis Observation, Visualisation, Quantative Data Analysis, Sketchbook, Photography, a Reflective Blog and Reflective Journal

Tools: APCC, AVA CAD CAM, Spectrophotometer, Mimaki TX2-1600 with reactive dyes, Textile Substrates (Cotton, Wool, Silk, Linen) and Microsoft Word and Excel, social media (WordPress blog and Instagram).

Know How

The researcher was familiar with this style of working having used archival research for inspiration in her professional practice. Additionally see previous examples of Know How in Colour Reference Book and Experimental Indicator Profiles

Know That

Colour use in the Interwar period was influenced by the introduction of new colorants and to a certain extent new printing mechanisms. Cultural debate

concerned itself with the evolving relationship between the role of design to technology and industrial manufacturing. This makes a striking comparison with the aim of the research inquiry to explore a designer's role in overcoming issues of colour outcome in DTP, a relatively new and outsourced technology.
Many of the colours associated with this period, smoky, dark, earth colours and neutrals are the hardest to replicate in DTP, as proven by the Colour Reference Book.

Using a body of design and colour work as a real-world test case provides an accessible, relatable, and visual means of demonstrating whether the methods developed by the research are useful. Testing in a real-world instance ensures that the results are unpredictable.

Designers will frequently work to a brief or are influenced by colour forecasts. Textile design is highly influenced by historical design with many designers re-envisaging and modernising past fashions and trends, for example, Cath Kidson. In the preliminary stages of design, the final substrate or intended end use may not be known so trailing different substrates is typical.

Limitations

The identification of colours for the digital colour palette and selection of archives was undertaken by the researcher and are therefore subjective and selective. The designs and positioning of colours were devised by the researcher and are therefore subjective and selective. The prints were made in a singular print environment and were not repeated. The analysis and annotation of the sample book using the three methods developed by the research project was carried out by the researcher alone. Additionally, all the limitations of the three methods: Colour Reference Book, Digital Lab Dip Tests - Colour Maps and Experimental Indicator Profiles apply.

Ways of Making Project Case Study – separate to PhD Research Project

Description: A series of forty-eight prints on Silk Satin, depicting eight images of a primrose by the artist, Sir Peter Blake. Each set of eight has a different experimental indicator profile applied to the images prior to digital printing. The prints were commissioned by the *Ways of Making* Project, a collaboration between Worton Hall Studios, Sir Peter Blake and CFPR, UWE Bristol and are held by the project's archive for an international exhibition tour. The series is a physical set of prints and accompanying digital files and sketches.

The piece was created in the CFPR research studio and Digital Print Centre at UWE, Bristol

Timeline July 2017 – November 2018

Intellectual Rigour

The aim of the *Ways of Making* project was to create an archive of every known medium, exploring edition making through creating multiple versions of an image through a variety of processes. The project brief asked researchers to reinterpret Blake's visuals through their print discipline, drawing upon their knowledge and skill set. These prints covered a wide range of disciplines which are explored within CFPR. The work presented from this research project to *Ways of Making* demonstrates an application of colour knowledge, which evolved from the investigations into colour assurance. The experimental indicator profiles applied were selected to produce the most extreme and aesthetically intense colour outcomes rather than the truest colour match. This artistic expansion of the work provides a different application of the profiles, separate to their intended purpose. The outcomes are thought-provoking and may lead to innovations beyond the scope of this project. The work meets Objective 4 'Establish a coherent body of colour work using digital textile printing'.

Know What

Critical Reflection

- Visual Observations and Audio Reflection through-out the design process
- Visual Observations were made of the images on screen to determine which experimental indicator profiles to use
- Visual Observations were made of the prints to assess technical details such as shrinkage as the prints needed to match the other mediums

- External Critique and Feedback
  - The work was discussed with supervisory team and members of research centre as well as specialist technicians through-out the process.
  - The work was presented at the CFPR 21st Anniversary Celebration to industry and academics

Methods & Tools

Methods: The overarching method deployed was Praxis. The praxis work was supported through the use of Case Study, Observation and Photography
Tools: APCC, Mimaki TX2-1600 with reactive dyes and Textile Substrates Silk Satin

Know How

The researcher's accumulation of colour expertise developed through-out the project.

Know That

Colour management processes use mathematical models and scientific theory to convert pixels to dots to produce perceived colour ranges. Algorithms are automatically performed out of sight and seemingly with little input from the user. In this instance, the technology was harnessed to produce aesthetically interesting and experimental colour outcomes retaining designer creativity. Modifying the colour data significantly alters the colour outcome, demonstrating the impact of colour management on printed colour outcome.

The *Ways of Making* project was initially inspired by visit to an art college where Blake became concerned with the usurpation of many forms of craft and hand skills by computer usage. This work demonstrates that, in the realm of digital colour printing, a designer may exert control by manipulating computer algorithms, thus preserving the designer's eye as ultimate colour control.

Silk satin is a highly reflective and finely woven fabric which produces vibrant, printed colour. Silk fibres absorb dye well promoting colour saturation, yielding brighter than intended, brash colours.

The experimental indicator profiles had already been tested on the screen but this application of colour knowledge to an artist's work explores avenues beyond the scope of the research project. The production of these prints presented a means of applying colour knowledge, developed by the researcher, to demonstrate the creative and exploitative potential of DTP.

Limitations

This is a single application of the experimental indicator profiles to prints. The work itself does not inform either aim of the project.

In addition

The work forms part of the *Ways of Making* project archive. A print from the series featured at the preliminary exhibition of the project at the London Original Print Fair, Royal Academy, London April 2019.

The Case Study featured in a journal article published in the Journal of Textile Design Research and Practice in November 2020 by the researcher.

Colour Conversation Case Study - Interviews and Questionnaires

Description: A series of interviews with industry experts about their experiences with colour and DTP. The interviews were conducted with the researcher remotely and recorded adhering to approved ethical stipulations. The experts were selected from a range of professions including newly graduated designers, established design studios, digital print bureaus, textile design agents, academic researchers, and leading designers in the field. In addition, questionnaires were completed by digital textile print technicians at HEIs contributing to a broader picture on digital textile print design education. The work consists of transcripts of the conversations and the completed questionnaires with accompanying ethical documentation.

The piece was created in the CFPR research studio at UWE, Bristol

Timeline September 2016 – February 2020

Intellectual Rigour

The Colour Conversations series evidences the key issues that the research project sets out to investigate as well as several hypotheses proposed by the inquiry. The series confirms that there are challenges with colour assurance in digital textile printing and that this is experienced by a wide range of stakeholders. The series corroborates that variables, testing and education are key to resolving problems, fortifying the suppositions of the contextual review and directions of experimental work. In addition, it revealed the impact that a designer's embodied colour knowledge has in resolving colour outcomes and highlighted the economic possibilities of this technology. Colour Conversations meets Objective 2 'Use interviews and case studies to identify the strengths and weaknesses of current textile printing practice' and Objective 3 'Co-ordinate a network of experts to facilitate colour conversation case studies'.

Demonstration of: Gamut Mismatches, Numerous Variables, Adapted Technology, Outsource Production & Design Education

Know What

Critical Reflection

- Preliminary reflection over ethical considerations including writing information documents and consent forms
- Consideration of the question material and formulation of questionnaires
- Audio Reflection through-out the process
- Internal Reflection over the selection of interviewees
- Audio Reflection during the transcription process
- Analysis of Colour Conversation series, summarised in a poster presentation

Methods & Tools

Methods: The principal method was interview and supported by a questionnaire. Additional methods used were transcription and a reflective journal.
Tools: Audio Communications (Skype, telephone, FaceTime), Audio Recording software (QuickTime and Dictaphone), Transcription Software (Express Scribe), Email Communication and Microsoft Word

Know How

As a design professional, the researcher has knowledge of the textile industry and therefore was able to communicate effectively with the industry experts about the issues they faced, comprehending their experiences.

Know That

Using a semi-structured, conversation-style interview as a method to gather data about the experiences of others, provides a means to explain, evidence and better understand the issue of colour outcome in DTP. The experience of designers with DTP has been investigated (Treadaway, Britt etc) but not specifically colour accuracy. Interviews are unpredictable and allow the inquiry to build knowledge that may not have been considered by the researcher solely through their embodied experience. The contextual review proposed that education in DTP in HEIs is mixed which the Interviews and Questionnaires were able to confirm. Questionnaires are useful when the recipient is busy and does not have time to be interviewed. In this instance, the questionnaires were completed by HEI technicians whose schedules require them to be present in studios working with students, whilst operating print machinery and therefore have less time to set aside for an interview.

Limitations

Many of the interviewees had concerns about commercial sensitivities and their professional standing and this impacted the extent of their answers. One industry expert wanted to remain anonymous due to concerns about their professional standing. Several industry experts who were approached were unwilling to participate or did not respond. This restricted the interviews to professionals willing to participate and provide their time and expertise for free. It was challenging to find people to interview from a digital print bureau, which limited the data gathered to primarily a 'designer's experience'. Interviews are limited by the selection and nature of the questions asked and the relationship built between the interviewer and interviewee. Interviewing remotely rather than in person will also impact the interview and the answers given because the relationship between the interviewer and interviewee will be affected due to the difference in interaction. Similarly, questionnaires are impacted by the selection of questions asked and require consideration to remove imposed bias in their formulation.

In addition

Colour Conversations was presented as a poster at the Textiles and Life, Textile Institute Student Conference in Manchester, 22 November 2017

Variable Testing

Description: Practical experiments investigating the impact of variables in the digital textile printing process. The work consists of digitally printed fabrics, many of which are annotated and supported by digital files, sketchbooks, and a reflective blog.

The piece was created in the CFPR Research Studio, Digital Print Centre, and Textile Studios (Dye Laboratory and Silk Screen Print Studio) at UWE, Bristol

Timeline October 2015 – August 2018

Intellectual Rigour

These ongoing and evolving practical experiments tested the impact that adjustments to variables had upon printed colour outcome. Early research identified several variables of significance (presented as a Poster at the PICS2016 Conference) upheld by findings from the Contextual Review and the Colour Conversation series. The experiments generated practical knowledge of the effect these variables have on printed colour outcome, demonstrating which ones? the designer might exert some control over, which were key in designer and printer communications, and which were essential to clarify design pedagogy, and resolve and correct, colour fidelity issues.

The experiments included

- Software adjustments (hue, saturation, vibrance, colour mode, halftoning)
- Colour Theory (Research Portfolio Module, complementary colours, colour wheels)
- Substrate pre-coatings
- Double and Triple pass printing
- Coloured substrates
- Colour profiles
- Pantone© Colour metrics
- Steaming
- Development of RedBubble Portfolio including Product Testing (Concept to Consumer, Drop Shipping)
- Testing of gradient and Granger Rainbow prints

The work meets the project Aim 1 ‘to develop a tool-kit…’ and Objective 1 ‘Survey and compare different digital colour printing systems for textile designers’ and Objective 4 ‘Establish a coherent body of colour work using digital textile printing’.

Demonstration of Gamut Mismatches, Numerous Variables, Adapted Technology

Know What

Critical Reflection

- Visual Observation and Audio Reflection through-out the evolution of the practical experiments
- Annotation and Sketchbook work, direct on the fabric prints
- Reflective journaling using social media (WordPress blog and Instagram)
- Examination and photography of selection of prints under the microscope to observe changes to the dithered dot matrix
- External Critique and Feedback
    - The work was discussed with supervisory team and members of research centre as well as specialist technicians through-out the process.
    - Consultation with external users (for example, the gradient tests were discussed with designer Jacky Puzey, an artisan digital embroidery specialist who approached the researcher for digital textile printing advice)

Methods & Tools

Methods: The overarching method was praxis. Supporting methods included Observation, Sketchbook, Reflective Journal and Photography

Tools: Adobe Photoshop Creative Cloud, AVA CAD CAM, Spectrophotometer, Mimaki TX2-1600 with reactive dyes, Textile Substrates (Cotton, Wool, Silk, Linen), Star Steamer, Nikon SMZ800 Digital Sight Microscope

Know How

The embodied knowledge of the researcher as described in previous activities. The lack of educational and professional background in textile chemistry, colour management and colorimetry ensured taking a practical and creative approach allowed the researcher to understand basic laws and concepts from these fields.

Know That

A variable is anything that can be changed in the environment under consideration. In addition, a variable may be something that it is possible to measure, to demonstrate the adjustment made or, to ascertain the impact that variable-alteration has made. The variables tested in this instance were those accessible by the researcher within the test print environment. The variables were identified during initial research stages to establish their effect on printed colour outcome.

Substrates and the colour of the design are key variables that designers have control over. Other variables such as coatings, secondary processes and colour management are within the control of the DPB. Designers may be unfamiliar with them but should be aware so that they can ask appropriate questions about how the DPB uses them.

Some variables such as the textile chemistry are unpredictable and difficult to control. These include reactions to changes in humidity and temperature and incorporate coatings and secondary processes as well as colorants, fibres, and cloth preparation.

Some variables such as software adjustments may require happenstance and embodied tacit knowledge to gauge.

Limitations

All these experiments were conducted in a singular print environment, each had its limitations and was a single case or instance carried out by the researcher

In addition

A poster presentation titled ‘The variables that impact colour outcome in digital textile printing’ was presented at PICS2016, September 2016 University College London, UK

The body of work developed from this activity forms the final output, Exhibition of Praxis.

Key Outcomes

There are three key outcomes from the research inquiry which are described below. The intention of this section is to record the research output and connect it to the aims, objectives, and research questions.

Exhibition of Praxis

Description: A presentation of the practical work from the research project. The exhibition is organised into four sections, an Introduction, Key Variables, Methods and Timeline. Each part presents a selection of practical research work and accompanying text, which is printed on large panels. Each display was documented using photography and a video recording to act as a durable record. The exhibition was displayed at UWE Bristol with the intention to be shown for Viva examination and taken out of the academy to show in a commercial gallery space.

The piece was created in the CFPR research studio at UWE, Bristol

Timeline February 2020 – October 2021

Intellectual Rigour

Through displaying a timeline of development of practical work in an exhibition format, this exhibition visualises and summarises not only the project's journey but the thought processes, outcomes, and findings of four year's research.

It is a summary of the project and is an accessible and visual means of disseminating the research. Having a physical format to complement the digital tool-kit allows viewers to touch, see and compare the printed fabrics. It is a physical iteration of the Tool-kit. This exhibition meets the project's Aim 1 'to develop a tool-kit…' and Aim 2 'to create an historical digital colour palette which, re-creates colours from the interwar period, as a real-world test scenario' and all Objectives. It responds to all four Research Questions and the two themes of the research project Colour Expectation and Colour Archive.

Critical Reflection

- Visual Observation and Audio Reflection through-out the process
- Visual Observation and Audio Reflection after a praxis run / Iteration One

- External Feedback and Critique
    - The work was discussed with supervisory team and members of research centre as well as specialist technicians through-out the process.
    - The exhibition was in a publicly accessible space and seen by students, staff, and UWE open day visitors. Feedback to the exhibition was positive although many commented that the exhibition was text heavy.

Limitations

It was tricky to represent the screen-colour in the Exhibition although a solution was developed using QR codes for some prints. The exhibition was seen by a limited audience.

In addition

Plans to put the exhibition on at Centre Space gallery in Bristol which were put on hold by the COVID pandemic will be revisited post submission.

Project Tool-Kit

Description: A website serving as a pedagogical device offering education, information and tools for designers using digital textile printing. The website structure complements the written report and exhibition of praxis and disseminates the research findings and methods. The Tool-kit is available at digitaltextilecolour.org and a pdf copy is submitted as part of the Doctoral Thesis (Appendix G)

The piece was created in the CFPR research studio at UWE, Bristol

Timeline September 2018 – October 2021

Intellectual Rigour

The Tool-kit documents the research praxis in a portfolio style and provides pedagogical and theoretical information on DTP. It is a key outcome of the research inquiry and meets Aim 1 'To develop a tool-kit….' and responds to Research Question 1 'What measures must a designer take to feel confident with their colour use in digital printing on cloth?' and Research Question 2 'How can scientific colour theory and production methods for digital printing be understood and utilised by the design community?'

Critical Reflection

- Visual observation and audio reflection through-out the design process.
- External critique and feedback – Sept – Dec 2021
- User testing – Jan 2022

Limitations

User testing has been limited as planned workshops did not go ahead due to COVID. The final work on the Tool-kit was delayed due to COVID and the resulting user testing was limited. It would be recommended the feedback is used to improve the Project Tool-kit in the future.

In addition

The Tool-kit is in development. Stage Two will include adding downloads/ tools to support designer's colour expectation knowledge

Complementary Written Report

Description: A written report of the research project detailing the contextual review, methodology and experimental. The report is both a digital text document and a physical bound copy.

The piece was created in the CFPR research studio at UWE, Bristol

Timeline May– November 2021

Intellectual Rigour

A written commentary of the research inquiry which takes the format of a traditional thesis (introduction, contextual review, methodology, experimental, conclusion, bibliography, glossary, and appendices). The report provides a complementary narrative to the exhibition of praxis and tool-kit. This is undertaken through the positioning of the project through a contextual review and the presentation of the methodological approach. The originality and new insights developed through the inquiry are signposted in the experimental, and conclusion. The use of contextual as opposed to literature review provides a more inclusive term which opens discussions up to the analysis of research beyond textual sources. It meets Aim 1 and 2 and Objectives 1, 2 and 5.

Critical Reflection

External Feedback and Critique

- Drafts were provided to the supervisory team for feedback and proofing
- Training sessions attended including 'How to survive your viva' and a Study Hub Day where feedback was sought on the report's contents and writing style

Limitations

The report includes documentation of the praxis through photography which is not a true representation of the praxis because of the nature of photography and computer software. The report is limited to describing a visual process using language which may be subjective. The report is limited to a set word count.

In addition

The written report will be submitted to the British Library as an open access record to include documentation of the praxis and will be available to download from the UWE repository.

Appendix C
Documentation of Exhibition of Praxis

This appendix presents photographic documentation of the Exhibition of Praxis and digital files of the Exhibition Banners.
The Exhibition was held from 7th- 10th October 2021, F Block Gallery, UWE, Bower Ashton

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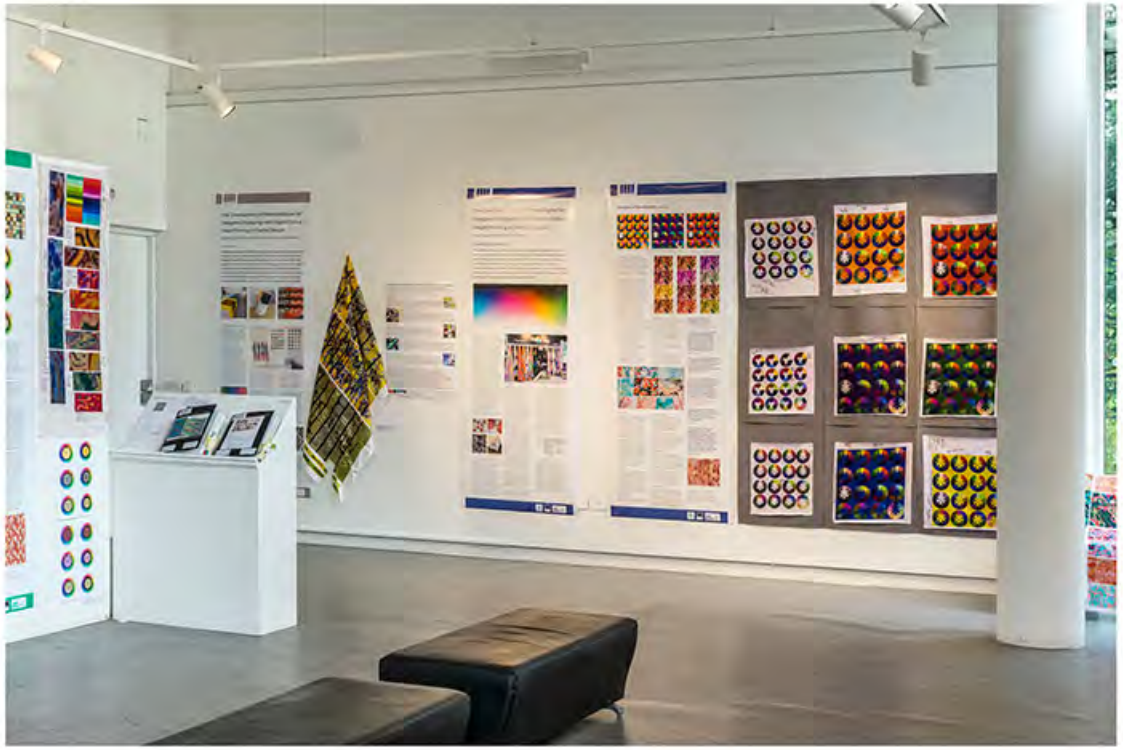
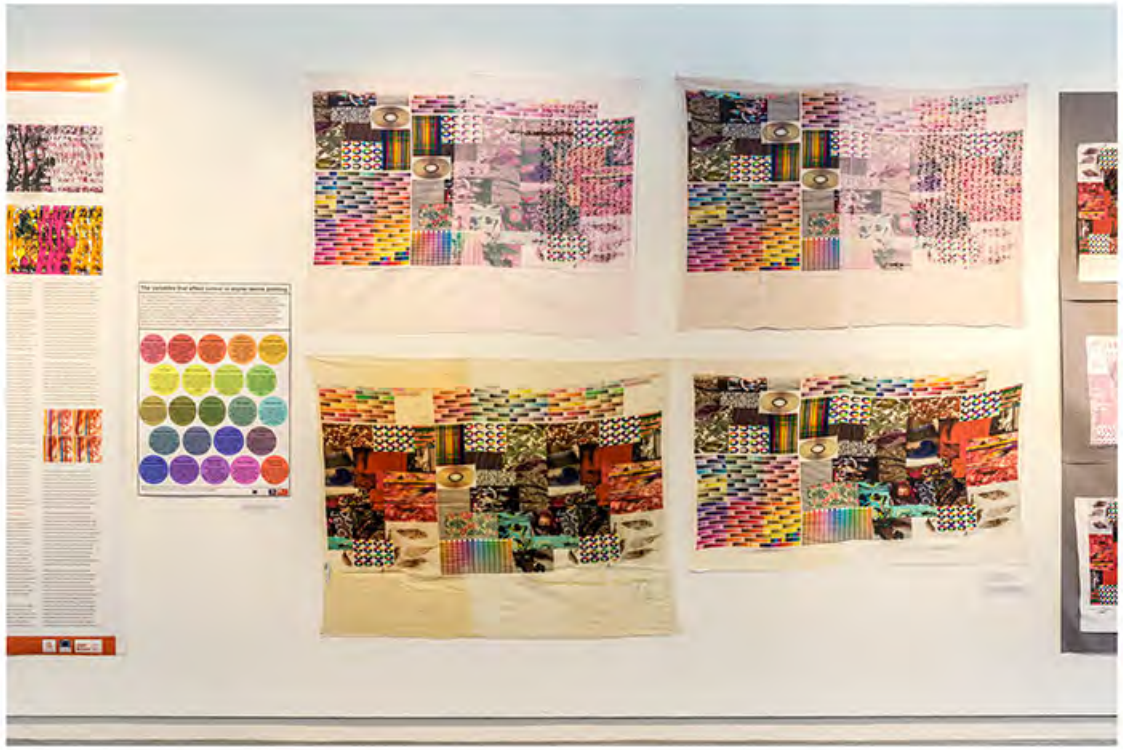
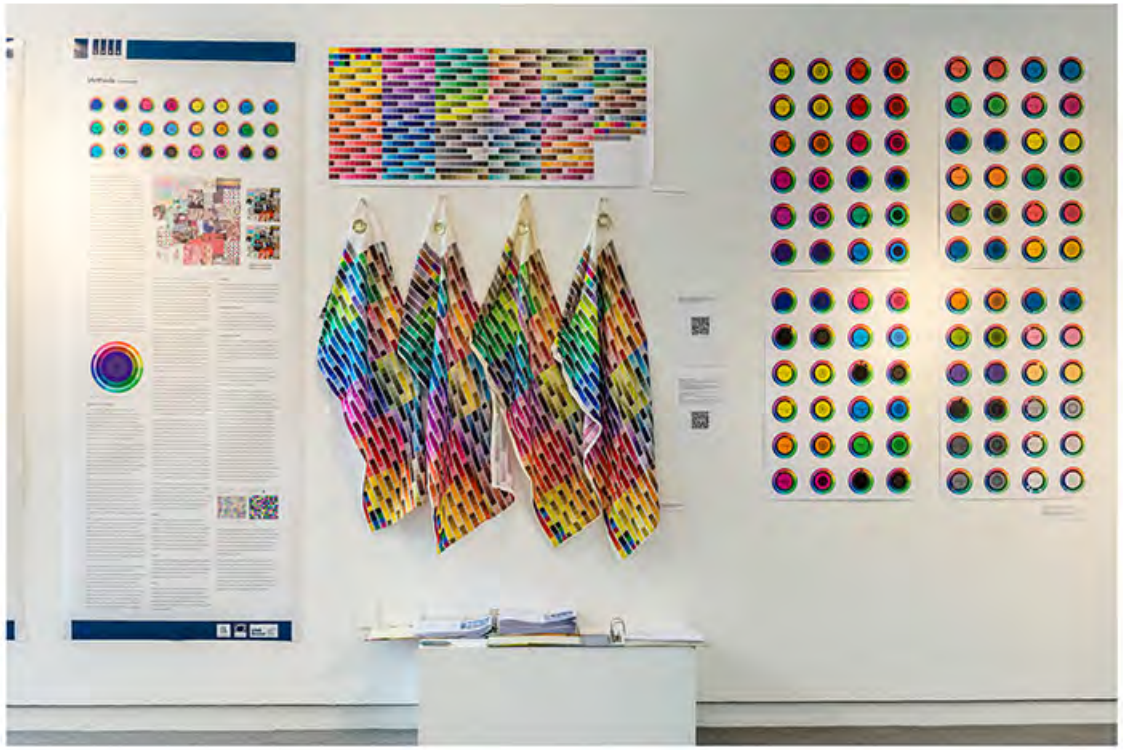


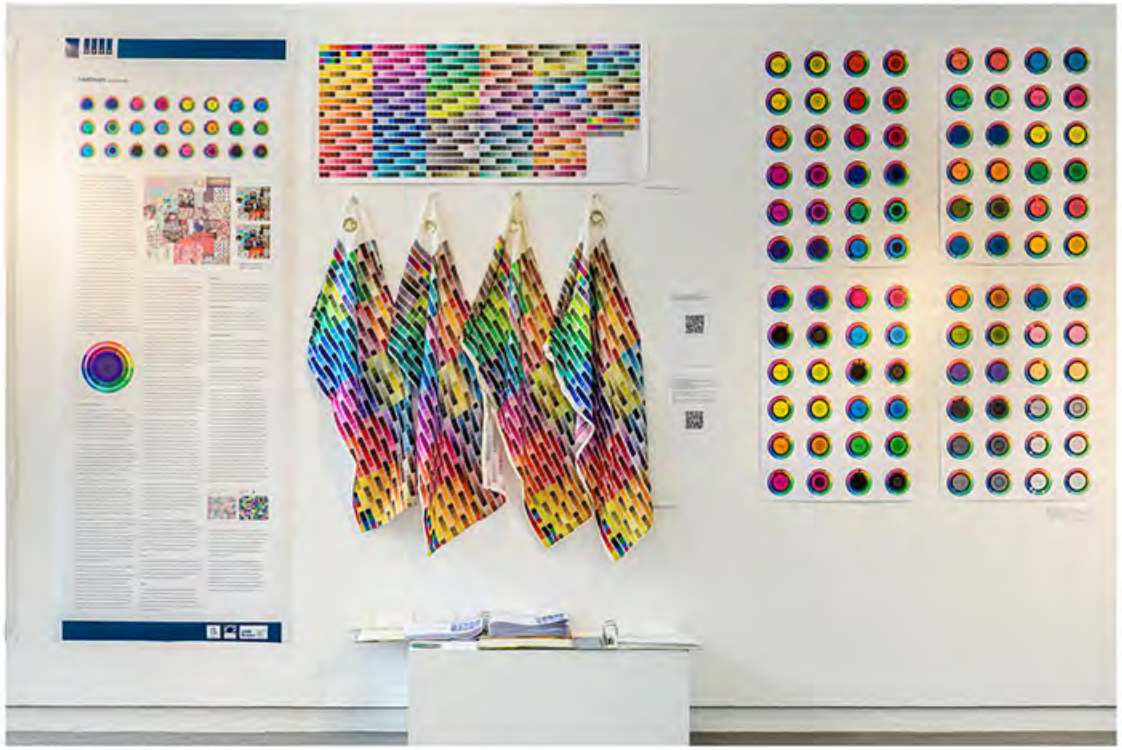
The Development of Methodologies for Designers Engaging with Digital Colour Inkjet Printing in Textile Design

The Development of Methodologies for Designers Engaging with Digital Colour Inkjet Printing in Textile Design

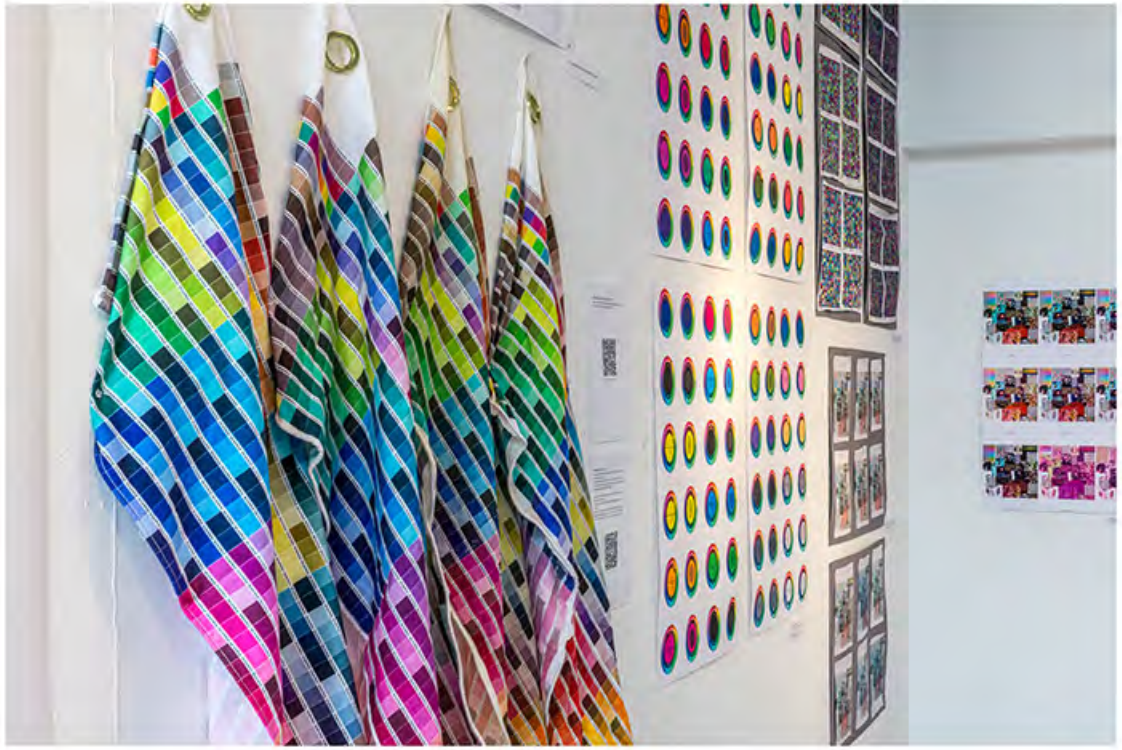


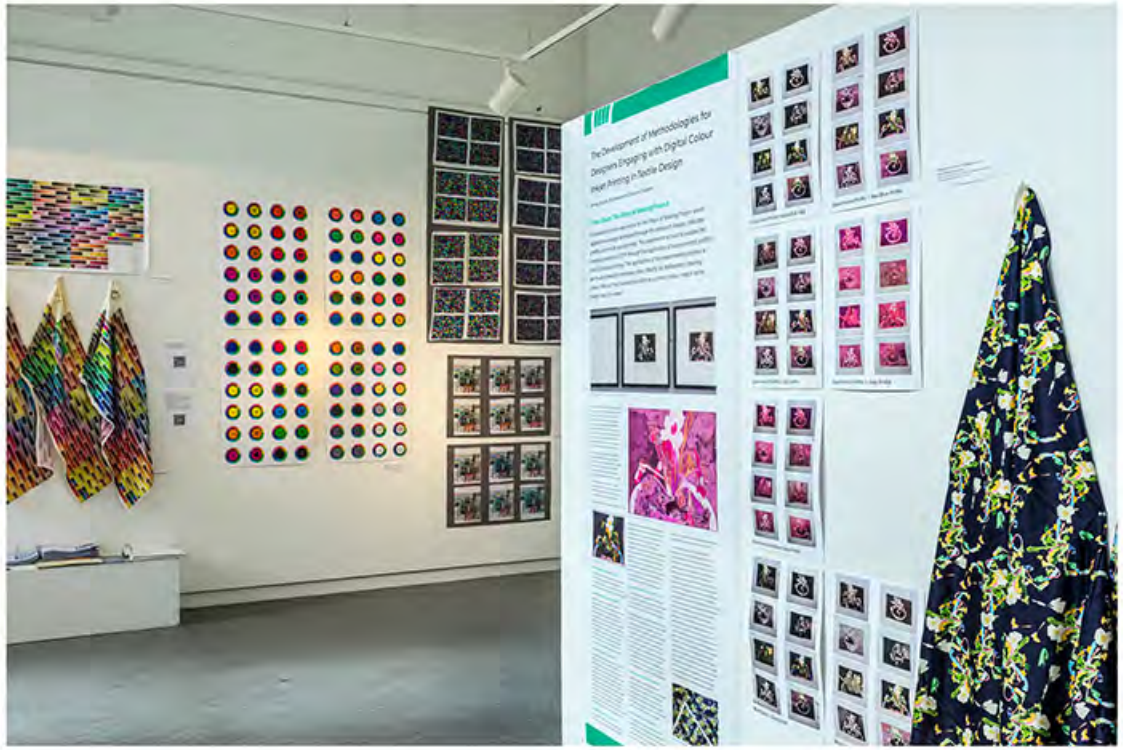
The variables that affect colour in digital textile printing





Pantone Colour Library Metrics
Becky Gooby

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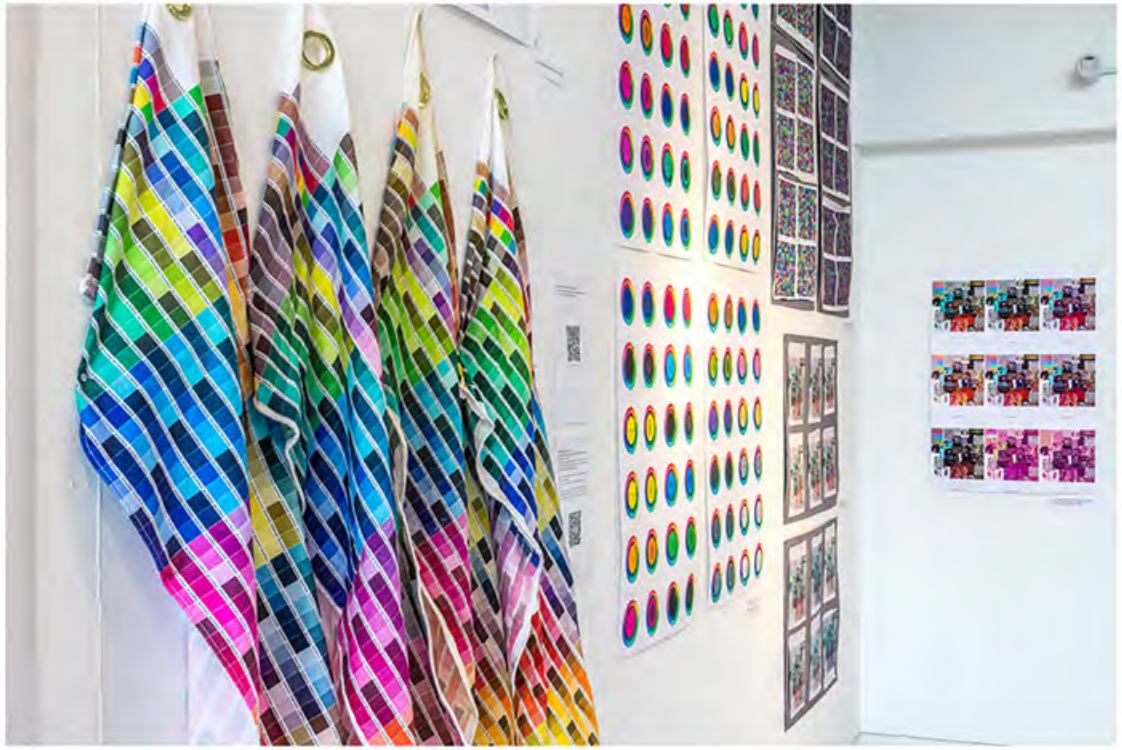

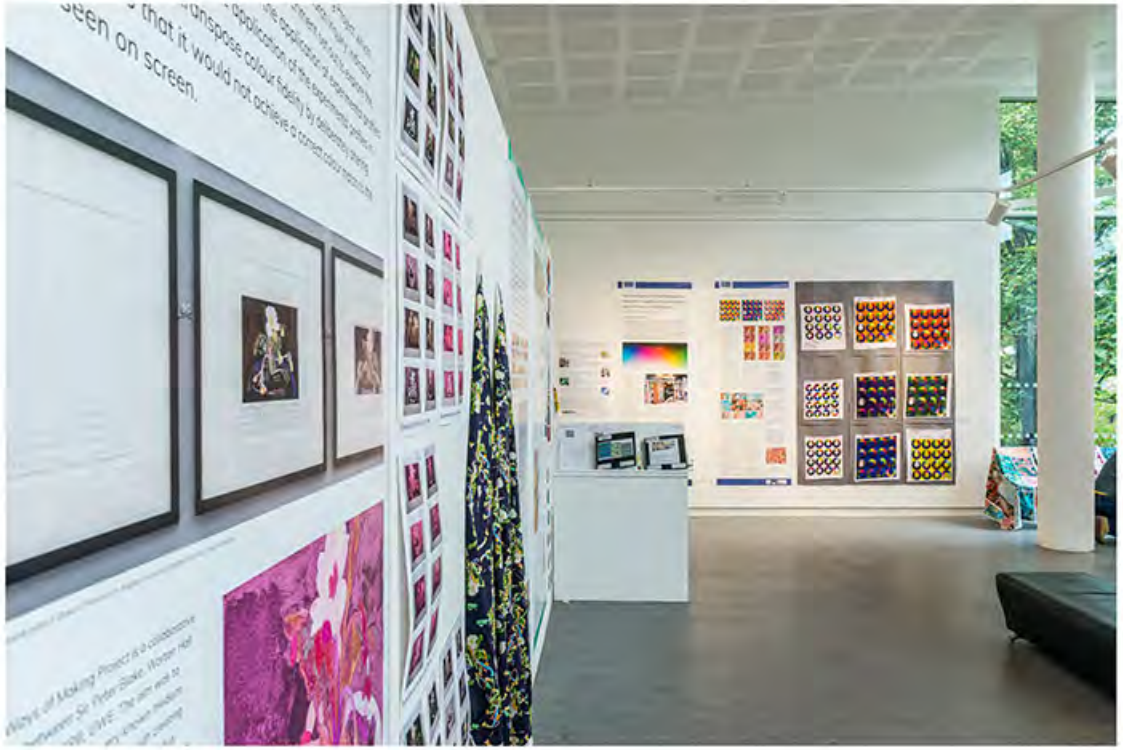

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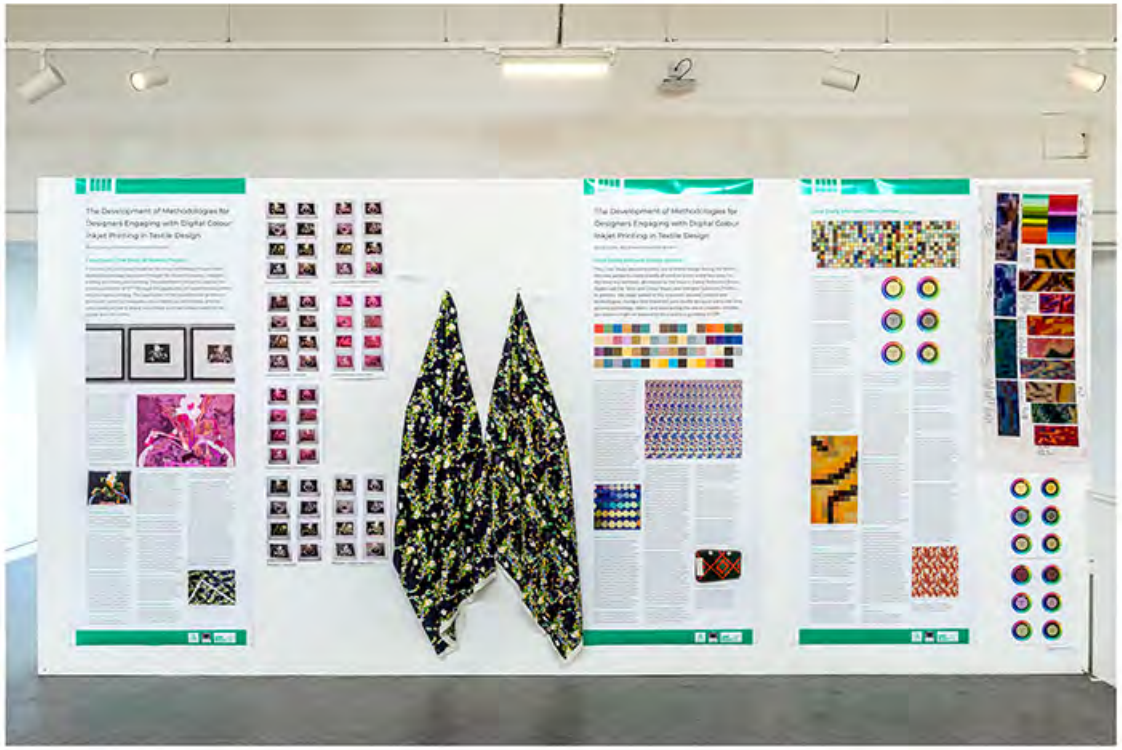
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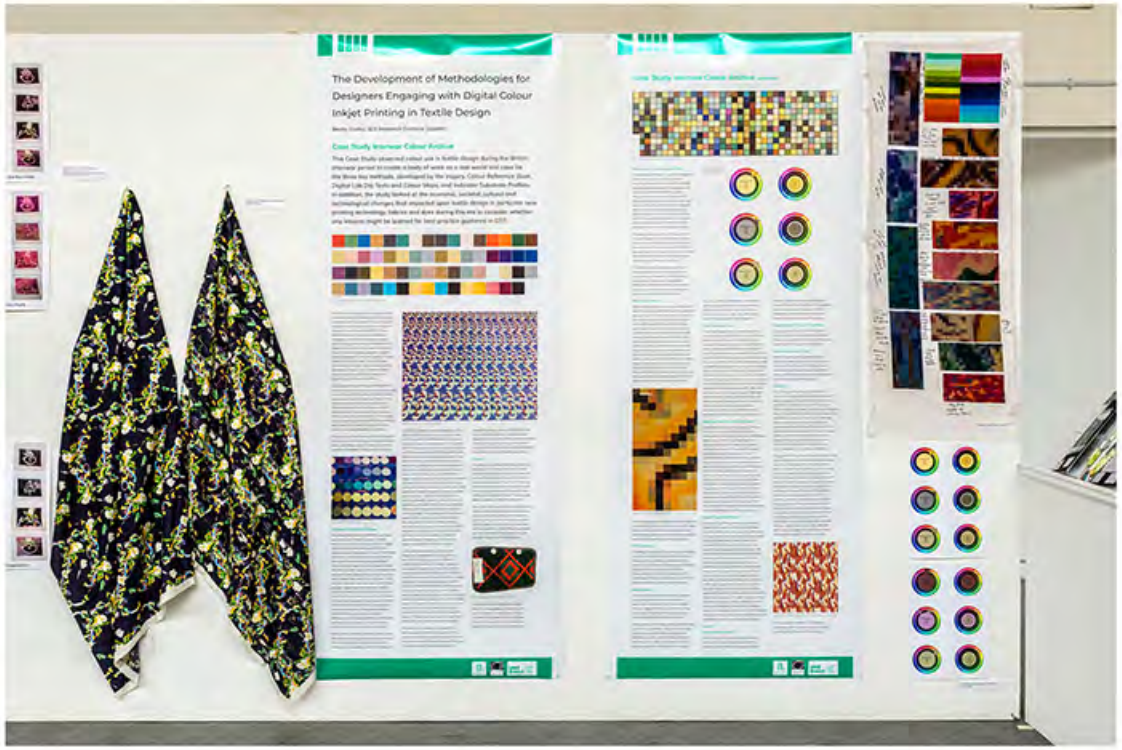
The Development of Methodologies for Designers Engaging with Digital Colour Inkjet Printing in Textile Design
Case Study: The Ways of Making Project
The Development of Methodologies for Designers Engaging with Digital Colour Inkjet Printing in Textile Design
Case Study: Intrinsic Colour Archive: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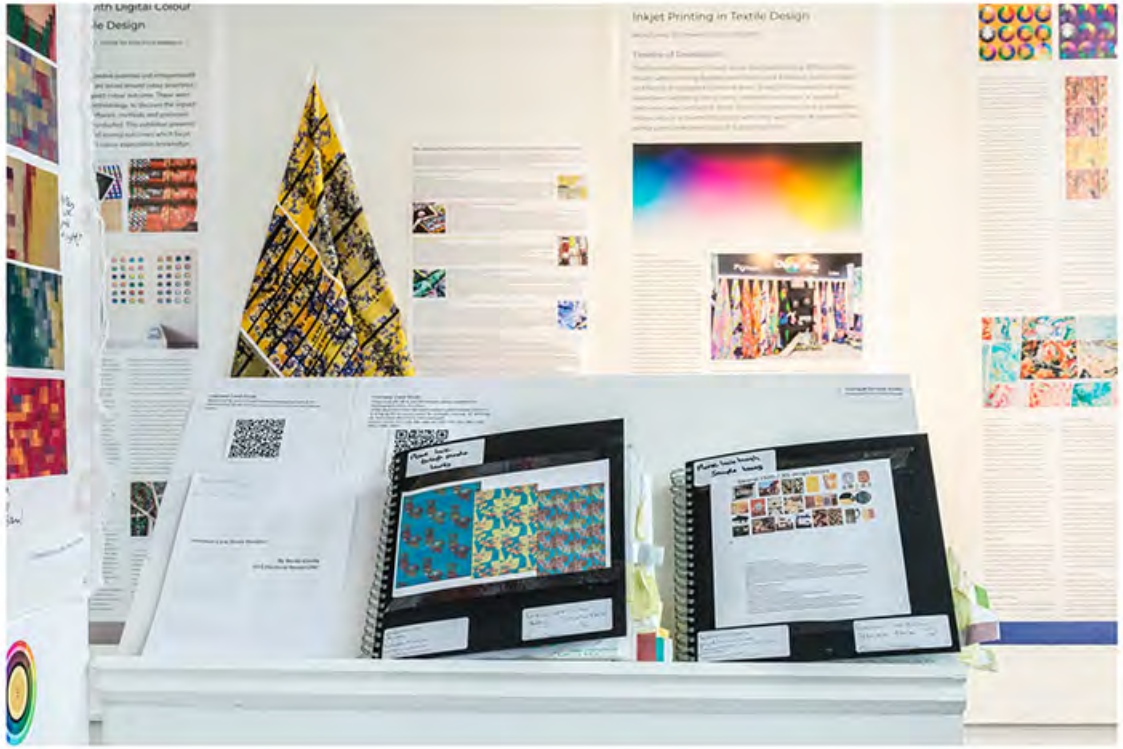
Inkjet Printing in Textile Design

The Development of Methodologies for Designers Engaging with Digital Colour Inkjet Printing in Textile Design

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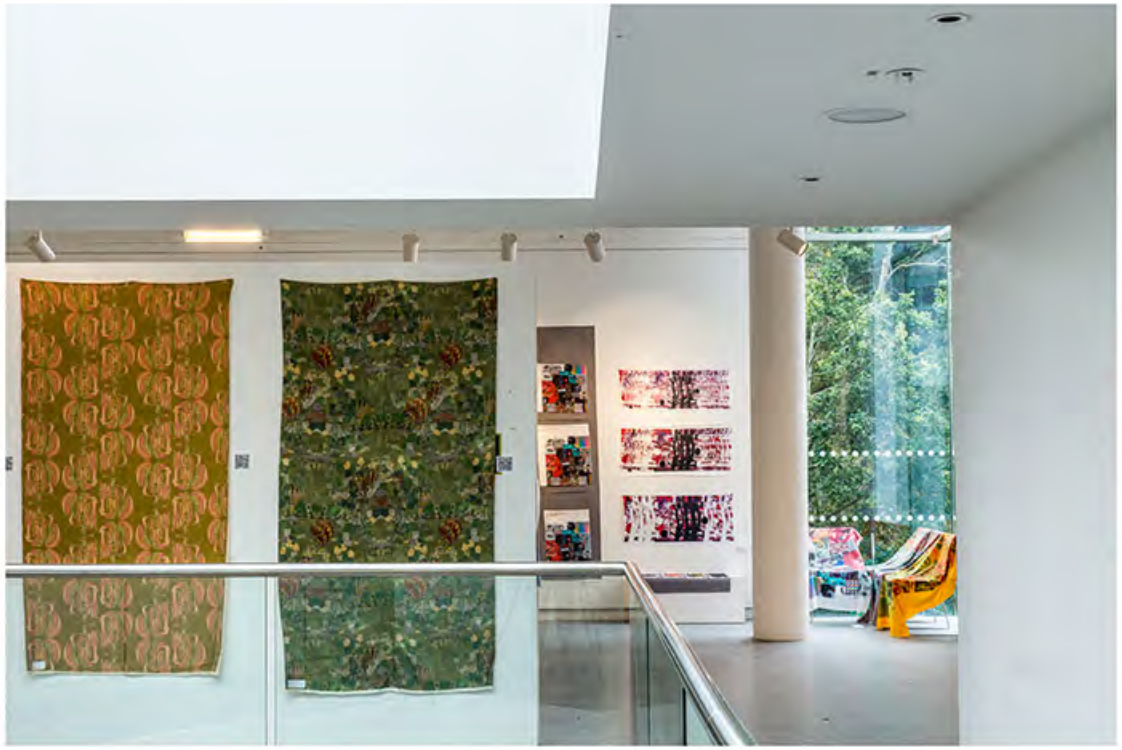
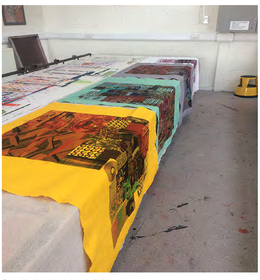


The Development of Methodologies for Designers Engaging with Digital Colour Inkjet Printing in Textile Design

Becky Gooby, 3D3 Research Doctoral Student, Centre for Fine Print Research

Introduction

Digital textile printing (DTP) offers exciting, creative potential and entrepreneurial business models in textile design but there are issues around colour assurance. Research identified the variables that impact colour outcome. These were explored, using a Practice as Research methodology, to discover the impact on printed colour. Additionally, existing software, methods and processes were surveyed and a contextual review conducted. This exhibition presents the culmination of these investigations and several outcomes which focus on developing methods to aid a designer's colour expectation knowledge.



Coated coloured substrates drying

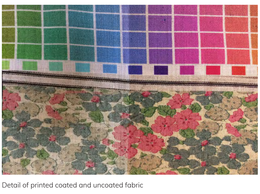
Colour measurement of printing ink sets

Prints drying after being steamed

The development of digital printing is a major change within the textile design process. A designer is no longer restricted to number of colours or repeat patterns and may include photographic images and intricate detail in their design work. It has become possible to print a metre, or hundreds of metres, at the click of a button, without large set up costs. This enables new entrepreneurial business models in the textile industry.

Digital textile printing (DTP) provides unprecedented opportunity for designers to offer bespoke and customisation of designs. Just in Time, Concept to Consumer and Drop Shipping production models benefit from short print runs and expedited strike-offs, product sampling and testing made possible by DTP.

Reduced ink wastage and water use makes DTP relatively, environmentally sustainable. Digital Print Bureaus (DPBs) are more likely to be located in an urban environment, local to their customers which reduces transport costs. DPBs occupy less space than a traditional textile mill or factory. Batch printing and the ability to react quickly to market trends allows businesses to carry less stock. This reduces storage costs and the likelihood of stock wastage as fabric is printed to demand. These changes offer exciting possibilities for designers and SMEs working in the textile industry.



Detail of printed coated and uncoated fabric

There are however, concerns about colour consistency and outcome. For example, there is a marked difference between screen-colour and print-colour. Software allows users to select colours unprintable using CMYK (cyan, magenta, yellow and black) colorants. The range of printing machines, and the methods that they use to apply, and represent colour, may also impede a designer's understanding. A textile designer will be required to experiment with a number of variables in order to feel colour confident which may be time consuming, costly and imprecise.

Digital textile inkjet printing (DTIP) is a non-surface-impact print process where colorants (primarily dyes, but increasingly pigment inks) are jetted in a dithered matrix of dots, onto specially treated fabric, to create the appearance of solid colour. The colorant sits on the surface although secondary processes allow dye molecules to further permeate the fibres. Additionally, DTP may include dye sublimation, solvent, latex, ultra-violet and direct-to-garment printing, for example T-shirt printers.

Digital screen colour, a mix of red, green and blue light, has a broader colour range to printed colour, primarily a mix of cyan, magenta, yellow and black (CMYK) pigment primaries. Whilst there are overlaps between the two colour spaces there are many colours possible in one but not the other, thus out of gamut. A gamut represents the boundaries of the range of colours a device can reproduce. These are determined by the colorants used and tonal information, i.e. the darkest producible black and the brightest white.

Exhibition of Colour Reference Book and Colour Maps at Data Ache, Plymouth

This research project considers how designers can achieve accurate colour results when digitally printing on a range of fabrics. The aim is to establish a best practice guide for designers wishing to obtain a more acceptable print-colour match. The guide will form an online toolkit to support colour knowledge in DTP, increasing the ability to resolve colour issues during design stages.

The work has been conducted using a Practice as Research methodology where knowledge is acquired through doing, and developed upon critical reflection. Textile design, and working with cloth, is naturally a tangible experience and so research undertaken in this field requires visual and tactile signposting. The inquiry, therefore, was representational of studio practice but used to study concepts from a broad range of disciplines including physics, chemistry, physiology, psychology, computer science and art and design. The thinking-doing approach has been informed by Nelson's understanding of Practice as Research and follows the know-how, know-that, know-what model of praxis he has established.

This exhibition presents work from these investigations and resulting visual indicator methods. These visual prompts support designers to build their own internal colour look-up table, enhancing their digital print colour knowledge and enabling them to predict and resolve colour issues during the design process.

The exhibition is broken down into four sections: Timeline of Development, Key Variables, Methods and Case Studies.

Timeline of Development – A selection of work from the outset of the project. Initial experimentation began by exploring a variety of colour concepts. A number of tests were made using Adobe Photoshop tools to determine their usefulness in achieving desired colour results. A further body of work was developed in order to understand colour theory and colour effects. In addition, this section presents reflections on the researcher's personal journey, a timeline of digital textile printing and a number of interviews conducted to establish issues with colour accuracy.

Key Variables - A number of practical investigations modifying key variables. The impact of colour management, pre-coatings, secondary processes and print passes on colour outcome were explored. There are numerous variables that affect colour fidelity in the digital textile print process which have been identified through this research. Many of these are out of the designer's control and difficult to predict. Some are distinct to DTP, such as the structure and composition of the fabric substrates and textile chemistry processes. Others are problems shared with the reprographics and photographic industry.

Methods - Three visual methods which demonstrate colour changes when digitally printing to textiles: a colour reference book, digital lap dip tests with corresponding HSB values and indicator ICC profiles. These can be used by designers to develop their colour expectation knowledge and allow them to make adjustments to design work in order to obtain a better colour match. The colour reference book may be used to look up different colours to determine how they might be expected to print on different substrates. The visual colour maps and digital lap dip tests, provide an indication of how a colour might alter in hue, saturation and brightness across substrates. Finally indicator ICC profiles reveal on screen an overall colour shift dependent on substrate so alterations may be made prior to print.

A selection of colour targets ready for measuring to create profiles

Case Studies - Two Case Studies, demonstrating an application of colour knowledge, generated by the research project. The Ways of Making Project, a collaboration with Sir Peter Blake, Worton Hall Studios and Centre for Fine Print Research, and Interwar Colour Study, an archival inspired body of work using a smokey interwar colour palette which are challenging colours to obtain in DTP.

This work was supported by 3D3 Centre for Doctoral Training, funded by the Arts and Humanities Research Council.

The Development of Methodologies for Designers Engaging with Digital Colour Inkjet Printing in Textile Design

Becky Gooby, 3D3 Research Doctoral Student

Timeline of Develoment

This Doctoral Research Project arose from experiencing differing colour results when printing digitally onto fabrics as a freelance textile designer and feeling ill-equipped to resolve them. Since 2015 research has been undertaken exploring colour tools, variables and theory. A series of interviews was conducted, titled ‘Colour Conversations’ and a contextual review set out to locate the project within the wider field of research. This primary and underpinning work is presented here.

A Granger Rainbow, a test image which shows the range of colours and tones that a screen can produce

Personal Journey

“This research project arose from personal experience. My expertise and experience are as a freelance, computer-aided-design, printed textile designer. Since first engaging with DTP in 2008 I have seen the industry develop in the UK. My experience of colour matching and consistency issues have been confusing and frustrating, primarily because the process is outsourced and because I was unware of the numerous variables. My background is in Fine Art, block printing onto fabric which became soft sculptural installations but shifted to textile design after undertaking a Masters in Design to refocus my career. I explore digital print as a medium using a mix of hand drawn and computer graphic techniques. The substrates I chose to print upon were determined by the end use or cost. Prints made on cotton had issues with warmer tones such as reds and oranges which were more vibrant than expected, yet greys and darker colours were bluer or duller. Prints on silk appeared too sharp, colours were acidic and highly saturated. Prints on linen were dull and muted, with colour shifts towards magenta. For example, dark grey printed as pale blue and primary hues appeared as pastels. My print bureau were not forthcoming and provided little advice about colour matching. I felt ignorant and at fault. Working in Adobe Photoshop (APCC) I made adjustments to designs using vibrance and saturation tools, annotating designs and making samples where possible get the best aesthetic match. Conversations with other designers revealed that this was a wider issue and that many were frustrated by colour results and lack of knowledge to how to resolve. This Doctoral Project seeks to provide answers and support for designers like myself working in digital print.”

Examples of differences between artwork on screen (left) and prints on fabric (right)

History of Digital Inkjet Textile Printing

Digital printing for textiles is a relatively emerging technology despite being in use since the 1970s . The first ink jet textile printer was a carpet printer, ‘The Millitoron’ which blew drops of inks onto carpet surfaces to create pattern designs. The first recognisable digital textile printer was produced in 1991 by Stork thirty years ago. The Stork TruColour TCP2500 was designed for sampling. In 1995 Stork’s Fashion Jet Textile printer was presented to industry, for small print runs and strike offs, a form of proofing. Mimaki, a Japanese company brought out their first TX series in 1998. However, it was only in 2003, that digital textile printing became an established technology with the presentation of machines by Du Pont, Mimaki and Reggiani at ITMA ‘03. Since then printing

Exhibition stand for Duravibe Colorants at FESPA tradeshow

speeds and output quality have improved making DTP a viable and competitive print option with traditional screen and rotary printing. Industry research and development continues to focus upon improving print head technology and enhancing colorants to continue this progression. There is a focus on dye sublimation printing and pigment inks which are lower maintenance and more economical. Yet the market continues to prioritise colour quality and fabric flexibility advocating for improvements to inkjet printing and reactive dyes which work provide breadth of colour across a range of fabrics. Many smaller specialist DTP companies have been bought up by larger household names, establishing DTP as a viable commercial investment.

Existing Colour Tools and Support

There are a wide range of colour tools, including websites, apps and equipment which purport to support colour fidelity and conversion. It can be tricky to ascertain which are useful or appropriate for aiding screen to print colour conversion in DTP, and many are costly. Most designers will be familiar with colour reference systems such as Pantone, where you can select, identify and communicate colour using swatches and reference data. Pantone have numerous products, some digital, some physical, as well as apps and software aimed specifically at the fashion and textiles market but they are costly. Design software producers, Adobe offer Adobe Colour, a free colour website with examples of colour harmonies as well as colour data which support creatives working with their software. Similarly they have colour apps and provide useful colour data and access to colour libraries like Pantone in their software via the colour picker tool.

Basic screen calibration has become automated across most operating systems and computer models making it difficult to do more than adjust the brightness of your screen or set the screen profile. Apple’s new True Tone technology allows the latest macs to detect changes in the environment to adjust the screen colour automatically.

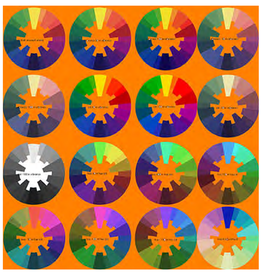
The usefulness of colour management equipment and colour subscription services will depend on the level and type of design work being carried out. For example a freelance designer may only need access to subscription services to gain colour information whereas a textile studio may need to purchase a simple colour management set up with calibration and measurement tools as well as a digital and physical colour swatches. Additionally there are many simple things that designers do such as creating a Granger Rainbow, a gradient tool which creates an image demonstrating the full range of colours a screen can produce for easy comparison. Furthermore keeping accurate records when assessing samples and checking colour matches whilst ensuring that the environment is as consistent as possible (same illuminant, time of day, neutral clothing) promotes best practice. A table of simple suggestions for colour tools is outlined below which demonstrates that freelancers can access lots of colour information and data for free or for minimal cost and shouldn’t need to spend much money on colour tools.

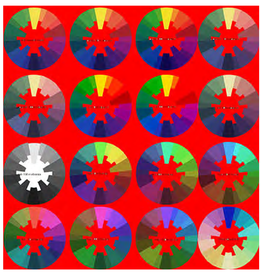
Suggestions for Colour Tools and practices for designers and SMEs in DTP	Level 1 Basic For freelancers, individual designers, students	Level 2 Advanced For design studios, SMEs, businesses working with suppliers, digital print bureau
Colour Library	• Use Colour Picker tools in design software to access colour data and free services such as Adobe Colour. Gain an understanding of different colour spaces (RGB, LAB, CMYK, LAB and commercial colour libraries eg. Pantone) • Might need minimal subscription services such as Pantone Connect or Pantone Live to access further colour information • Use mobile colour apps which can match colours from photos and images to colour data for example Pantone Capture • Ask if supplier supply a printed or digital colour chart / get a physical copy printed on the fabric(s) you work best with or a cotton satin and have swatches printed on it to help you match to digital artwork.	• Create a library of on-screen digital colour swatches or create a bespoke set with your DPA or your printer • If using Colour Management software use this to create digital and physical colour swatches • Invest in subscription such as Pantone Connect or Live and wider Adobe Colour account services • Consider having a set of swatches for different fabrics
Colour Management	• Set a screen profile that is suitable for working between DTP and screen • Use Granger Rainbow method to assess screen colour range and compare to printed sample • Examine fabric samples in a consistent environment and keep records about time of day, light source, neutral clothing, use a piece of grey neutral clothing. Use a piece of grey card or cut out as a frame to view samples through to neutralise your colour perception	• Purchase a basic colour management tool kit to be used in a consistent environment (ideally in a closed loop colour environment (where all devices are integrated and colour controlled) • Regularly calibrate and create profiles for your unique colour environment

Initial Experimentation

Colour Wheels – A set of prints were made using different colour wheels from the additive, subtractive and partitive colour systems. These were placed in a grid series. Simple adjustments were applied using APCC tools; Hue/Saturation, Vibrance and Inverse tool. The changes were made in gradual increments and reductions of 50 (from -150 to +150) where applicable and these changes were recorded in text in the centre of each wheel. These files were then printed onto Cotton Satin using the Mimaki digital textile printer and assigned the colour profile sRGB IEC61966-2.1 as the default profile of the print environment. observed and annotated.

Timeline of Develoment (continued)





Photoshop adjustments made to colour wheels positioned on coloured backgrounds to test out laws of contrast theory.

The second set of prints using only the partitive colour wheel but set against coloured backgrounds tested the impact of colour harmony. These files were printed onto Cotton Satin using the Mimaki digital textile printer and assigned the colour profile sRGB IEC61966-2.1. This experiment was conducted to see how the perception of colour changes when placed alongside another colour. The prints were observed and annotated.

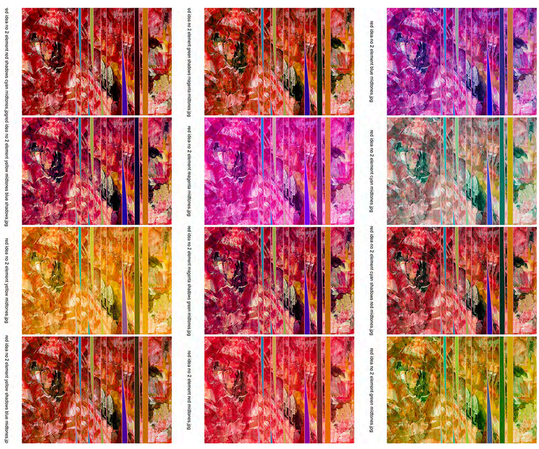
A comparison of the printed versions with the images of the screen showed a considerable difference in luminosity and loss of definition and detail. The printed colours seem to merge into each other whereas the sections of each wheel are more apparent using computer aided design (CAD) files. There was a clear difference in colour perception for the partitive wheels printed on coloured backgrounds. In particular, the red and purple backgrounds showed a clear dominance, making other colours appear darker and duller.

A second experiment set out to observe colour changes using a tonal design with APCC adjustments to determine colour outcome changes. A tonal design was chosen because it was more challenging to detect colour mismatches as opposed to the colour wheels in which colours were separated.

This design was adjusted using the colour balance tool, increasing or decreasing the colours in the highlights, midtones and shadows. The file names were saved to show what adjustment had been made. The prints were observed and annotated. It was observed that altering the opposite colour's shadows increased the depth of the complementary colour. For example, increasing green shadows made a stronger red print.

These initial experiments were rather playful and followed on from the working method of the researcher when carrying out colour correction methods.

Further experiments were conducted using other APCC tools such as halftoning and gradient tools. A range of colours were tested through producing a set of marbling prints which are also displayed here.



Photoshop adjustments made to tonal images to test out colour tools in the software.

experiments presented in this exhibition. Research in this field comes from several areas; textile and dye chemistry, printer technology, textile science, fibre technology, surface and coating technology, environmental and sustainability endeavours, textile engineering, and textile design. The history of DTP was mapped and a survey conducted of printer ranges, application methods, supportive tools and digital textile printing education.

Findings of the Contextual Review

The research presents four key themes which determine the colour outcome problem.

Gamut Mismatches

There is a mismatch between the gamut range of the digital screen colour to that of the printed colour. Whilst there are overlaps between the two colour spaces, there are many colours possible in one, but not the other, thus out of gamut.

Print of marbling artwork to test a range of colours.

Contextual Review

A contextual review was initiated at the outset of the project and continued through-out. Both textual and non-textual sources (exhibitions, trade shows, interviews, observations of products and artefacts) were considered. The aim to locate and justify the need for the project within a broad field of research, identifying any gaps in knowledge and evidencing the colour outcome issue, as well as supporting the evolution of the practice.

Research has been examined in the field of DTP and beyond, encompassing, but not limited to; colour theory, colour and colour use, digital printing in other mediums, DTP from a scientific and manufacturers perspective, design history (interwar period presented as a case study), colour management, colour measurement and colorimetric analysis, textile chemistry (dyes and inks, pre and post processing), and design education. Additionally, the research has considered how colour mixing and colour theory is explored in the visual arts.

Colour Theory

The study of colour is complicated and complex, not least because colour sources can be spectral or from colorants (pigment) and are dependent on context. This research concerns the difficulty of synchronising the additive and subtractive colour systems. A historical review of colour theory was conducted to establish which discourses might be helpful. A summary of colour theorists, systems and practitioners identified as useful, and a synopsis of their ideas outlined.

Digital Textile Printing

The review investigated the variables that impact colour outcome which in turn fed into practical

Numerous Variables

There are numerous variables that affect colour fidelity in the digital textile print process. Some are distinct to DTP, others are problems shared with the reprographics and photographic industries. Many of these are out of the designers' control and are difficult to predict.

Adapted Technology and processes

Added problems stem from the adaption of existing print machinery and colour management systems from reprographic printing technologies, which do not accommodate for textile chemistry, characteristics of cloth substrates, and the pre-requisites of their end use.

Design Education

Digital colour education is inconsistent across undergraduate design curricula and there is an insufficient understanding of DTP in the wider design community. There is no best practice guidance on colour in DTP from industry bodies such as Society of Dyers and Colorists or ASBCI and a lack of standardisation in industry.

The culmination of these challenges is that achieving colour fidelity in DTP is problematic. Current solutions of conducting frequent re-prints, increases wastage, and so a general acceptance of colour mismatches or using design tricks to disguise discrepancies occurs.

Colour Conversations

A series of interviews were conducted with a range of designers and SMEs, industry experts. titled 'Colour Conversations'. These supported the conclusions of the contextual review and established the direction of the project to produce an accessible toolkit whilst developing a set of experimental methods. The themes from the series are summarised in the poster displayed here.

"It's a brick wall I have banged my head against for the past three years."

Digital Print Bureau talking about colour in DTP

"I've stopped using black and went for a really deep sort of maroon burgundy shade... I think I've tried to avoid it since or I've warned a client there's a lot of black in here you need to be aware that that might be problematic."

Design Professional

"At no point did the printers give me any guidance on obtaining the colours I wanted, I was not for instance provided with a colour profile or a recommended colour space to use."

Design Professional

"I'd say the washing is now its always difficult especially in this country and for us particularly we're an old company and a lot of our factories are quite old and quite open so really we have tight constraints on the conditions its really difficult."

Textile Company who make and print their own fabric, discussing variables that impact colour outcome.

"we've learnt to accommodate those differences (in substrates) and make allowances for them when we're preparing our digital files."

Design Studio

"I wasn't aware I literally did designs work on the photography images had all my prints come through and I'd be so disappointed with a lot of purple all the purple that came through I wasn't aware of all the teals turned navy blue so that was horrible and I just had to deal with it."

Textile Design Student

Artwork testing out halftone tool in Photoshop

The initial experiments, contextual review and colour conversation series led to a practical exploration of the variables that impact colour outcome which are presented in the Key Variables part of the exhibition.

The Development of Methodologies for Designers Engaging with Digital Colour Inkjet Printing in Textile Design

Becky Gooby, 3D3 Research Doctoral Student, Centre for Fine Print Research

Key Variables

There are numerous variables that affect colour fidelity in DTP. Many of these are out of the designer's control and difficult to predict. Some are distinct to DTP, such as the structure and composition of the fabric substrates, the fabric pre-coating and the secondary processes. Others are problems shared with the reprographics and photographic industry. A textile designer will be required to experiment with a number of variables in order to feel colour confident. Research identified twenty-three of these variables. Several were tested to determine the impact on colour which are displayed here.

Close up of a print being fed through under the print heads.

The variables that affect colour outcome were outlined at the start of the project. These are presented here as a poster. Many will be out of the designer's control but gaining an understanding of their impact will assist in identifying and resolving colour issues. The research practice displayed demonstrates testing of pre-coatings, coloured substrates, steaming post treatments, multiple print passes, colour profiling and altering colour management processes.

Pre-coatings

Fabric intended for digital printing requires an additional treatment to prepare them for printing. The chemistry for these pre-coatings, sometimes described as a pad liquor, has been adapted from binder and thickener recipes used in traditional dye and print pastes. The addition of such agents enhances the resulting print colour quality and provides fixative properties for textile end uses. Different coatings are required for different fibres and further variations needed, dependent on colorant (reactive, acid, disperse dyes or pigment ink). They cannot currently be added to inkjet colorant because of viscosity and stability restraints, necessary to obtain precise dot droplets from the print head. In addition, the binders and thickeners tend to dry out, which consequently clogg up print heads and degrade print machinery.

Detail of print made upon coloured coated cotton.

Pre-coatings are applied to the entire substrate in a separate print preparation process via immersion, spraying or screen printing. Digital Print Bureaus (DPB) commonly purchase pre-treated fabrics or coat fabrics in-house. Once printed, the substrate is steamed and washed to allow the binders and thickeners to react with the colorants, enhancing the achievable colour gamut and quality.

To test the impact of fabric pre-coating on colour outcome a mix of urea, soda ash and Manutex, a seaweed thickener, was applied to an assortment of untreated fabrics. The formula was derived from several pad liquor recipes which were encountered through the undertaking of a contextual review. The coating was applied using a variety of methods; screen printing, spraying and dipping. An area of fabric was left untouched as a comparison. The prints were made using the Mimaki TX2-1600 inkjet textile printer with reactive dyes.

The untreated areas show a lack of definition, print quality and colour take up. Colour is vivid and bright in the treated of the cellulose fabrics, Cotton and Linen, although the print quality is only tolerable. The untreated areas the Wool and Silk, protein fibres, appear less affected in terms of colour uptake. However, protein fibres naturally absorb dye well. The image quality is also impacted, although more noticeably on the Wool print than the Silk, perhaps because of the differences in the tightness of the weave.

15 Minutes in Steamer, Wash at 60 Degree

30 Minutes in Steamer, Wash at 60 Degree

60 Minutes in Steamer, Wash at 60 Degree

120 Minutes in Steamer, Wash at 60 Degree

No Steaming, Wash at 60 Degree

No Steaming, No Wash

Set of prints with different steaming times for comparison.

The coating mix was screen printed using a motif pattern to explore the potential of producing creative colour effects. This creates some appealing aesthetic contrasts between faded and saturated prints. Here the same coating recipe was used for all four substrates, however different fibres would require different coatings to enhance dye uptake and colour fastness. This test demonstrates the clear impact on colour outcome that pre-coatings have in DTP, especially for cellulose substrates.

Coloured Substrates

The coating mix was used to treat coloured fabrics to demonstrate the affect that the colour of the substrate has on colour outcome. Textile prints are often applied to coloured substrates, which are dyed before printing, so that the fabric becomes an additional colour in the printed design. A discharge paste may be used to remove the colour from designated print areas so that the substrate doesn't impact the printed colour. In this experiment the printed colour was applied directly to the dyed fabric without prior colour removal. An initial set of prints were made using an Epson Stylus DX400 desktop printer as part of initial explorations of colour theory. The impact on printed colour was significant and therefore the opportunity to further explore coloured substrates, by pre-coating dyed fabrics, and printing on the Mimaki, was deemed constructive.

Four prints were made, three on coloured substrates, yellow, grey and light green, as well as a white control print. The colour outcome of these prints produces some interesting affects in particular the prints onto green and grey cloth. The colour quality appears mellower and is aesthetically distinct. The saturated colours are duller, yet appear dimmer, than in the control print onto white. The print on yellow produces some sharp and some earthy colours which have great impact on the overall appearance. The blues become greener and yellows are less distinct. The yellow of the substrate is a dark yellow which is a discord hue. Pure yellow is the lightest colour and darkening it creates an anomaly. The effect from this an printed colour is to decrease simultaneous contrast, where colour is perceived differently due to visual influences from adjacent colours, producing an appearance of sharper hues. In addition, the increase in primary yellow by combining a yellow ground with CMYK dots produces more broken hues, earth colours, due to an unequal colour mix. Grey is in the middle of the colour scale. Colours printed onto grey will lose their intensity and brightness which is apparent in these prints. Printing on grey, like discord hues, reduces colour effects such as simultaneous contrast ensuring clear colours. The light green is a light discord as green is towards the darker end of the colour scale but is used here in a light tint in order to make out the printed design. Pastel colours are light discords and act as a highlighter for printed colour. In toning down the printed colour the coloured grounds create pleasing colour harmony and reducing intensity. The green and grey emphasises more delicate shades in the print whereas the yellow creates richer colours not normally encountered in digitally created images.

The ability to print on coloured backgrounds could be utilised by designers, SMEs and educational institutes to exploit creative potential. Furthermore, there are sustainability possibilities through coating existing fabrics to be reused or customised. There is also the potential to screen print or embroider fabrics which could be later digitally printed, to produce exciting design work. Coating your own fabric could reduce the cost of DTP for designers and students at educational institutes, increasing engagement.

Detail of print made onto partly coated cotton. Coating applied using screen print pattern.

Steaming post treatment

To determine how the steaming process affects colour outcome six test prints were made onto pre-treated Cotton Satin, using the Mimaki printer. The Cotton Satin has proven the closest, visual colour match to screen-colour in previous tests. The prints were all steamed for different time periods before undergoing normal washing conditions after which a visual comparison was made. The shorter steaming times produce more vibrant colours but the sixty-minute steam achieves the best colour match to the screen. The longer steaming time of one hundred and twenty minutes has led to dye bleeding. The print left un-steamed but washed, demonstrates poor fixation. The print left un-steamed and not washed, remains unfixed and the colours are noticeably duller and darker where excess dye has not been removed.

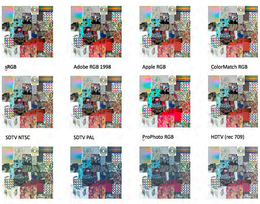
Key Variables (continued)

Multipass print. Colours over printed in separate layers.

Professional, industry recognised tests, to check the fixing and therefore the fastness (light, rub and wash) of the fabrics were not carried out to determine whether the shorter steaming times still met textile industry standards.

The steamer used in this experiment is an industrial star steamer but a survey of other DTP set ups showed that a range of equipment was used to fix printed fabric with varying results. A small set up with access to only a steam iron or smaller steaming equipment reported that they had to frequently experiment with steaming times to achieve better colour matches. Larger industrial set ups reported issues with transferring unfixed prints to steaming rooms, where colour outcome was affected by the humidity and temperature of the spaces the unfixed prints had to be transported through before being steamed. A DPB described how steaming post treatments were challenging to control.

From these experiments the research observed that variables that affect textile chemistry have a considerable impact upon colour outcome but are challenging and not controlled by the designer. A designer should be informed about their impact and ask questions of their DPB to assess whether their pre-coating and post treatment processes are adequate for their needs and to question these processes when prints are returned which have not achieved the expected colour outcomes. The changes to colour outcome offered by altering these variables may well be exploited for their creative possibilities, particularly the coating mixes, allowing DTP a broader artistic remit and developing aesthetic languages in DTP.



Colour collage image with different profiles applied.

Colour matching problems are not limited to DTP; colour assurance is an issue in paper printing as well. Yet as DTP is a more recent technology, colour management software and technological solutions have consequently been developed for reprographic and photographic printing industries and since been adapted for textile printing. Such methods aim to regulate colour processes and enhance colour data conversion. However, digital colour management does not yet accommodate for the textile chemistry although there have been developments. The characteristics of cloth substrates, and the pre-requisites of their end use, further compromise such methods optimised for paper printing. Managing colour results in DTP is therefore more challenging and lacks standardisation or best practice guidance.

Profiling

Colour Management processes such as profiling have been developed to maximise a device's achievable gamut. Digital images use a profile, a colour recipe, to transfer data on colour construction to output devices. This aids conversions between the colour mix on screen; RGB - red, green and blue pixels of light, and colour representation made by the printer; CMYK - cyan, magenta, yellow and black dots of colourant. These two, colour spaces overlap but there are many colours possible on screen that cannot be replicated in print, and vice versa. The profile will provide information on how to print such out of gamut colours, varying the colour outcome.

A number of prints were made, after observing differences on screen to an image file, a specifically created colour test collage, in Adobe Photoshop Creative Cloud (APCC), by assigning different virtual device ICC profiles. The prints were annotated and are displayed here. This experiment followed a similar exercise carried out by Professor Carinna Parraman investigating colour outcome in paper printing.

ICC profiles were developed by the International Colour Commission in 1993 as an open profile format which could be used universally across different software and devices. Data is stored in a colour look up table, used for converting an input to an output value. Profile maker software uses a colour target, a set of colour patches, which is measured. The returned data provides information for the colour look up table. DPB's may recommend that supplied artwork be assigned a particular ICC profile, generally a virtual device profile, for example, Adobe RGB

Multipass print. Colours over printed in two layers.

1998 or sRGB IEC61966-2.1, which have been developed for general colour management use. However, these may provide the designer with a false idea of colour reproduction possibilities as their gamut boundaries are far wider than the colours achieved using CMYK colorants.

The colour test collage images have been printed onto Cotton Poplin using Durabrite pigment inks on an Epson Stylus DX8400 which is a standard desktop home printer. The Cotton Poplin was cut into A4 size sheets and an A4 postage label applied to the back to enable the fabric to feed through the printer mechanism. This set up enabled the researcher to test the profiles without the input of a Raster Image Processor (RIP) which applies additional colour conversion processes and operates the wide format digital textile printer.

The profiles assigned are the standard RGB virtual device profiles available in APCC. These colour space profiles can describe independent colour spaces in either RGB or CMYK ranges. For most profiles the colour differences are subtle with the exception of Pro Photo RGB, a photography profile developed by Kodak which increases the overall saturation creating a more intense but lighter colour range. The most widely used are Adobe RGB 1998 and sRGB IEC61966-2.1. Adobe RGB 1998 was designed to represent most of the colours reproducible in photographic film. The colour range encompasses saturated, bright colours making images appear vivid. sRGB IEC61966-2.1 was designed as a display monitor profile and incorporates all the colours reproducible by an average computer screen. In comparison to Adobe RGB 1998 colours are darker and duller but images have good tone reproduction. Many print bureaus assign these profiles to a computer aided design (CAD) before converting for print via a bespoke profile for their print environment to standardise colour conversion.

This experiment explores several colour variances, primarily the colour differences between the applied profiles. However, the resulting differences in colour between the screen and print colour across the range of profiles was observed. A designer will need to understand the impact of assigning a profile to their CAD and should seek advice from a DPB on which profile is appropriate for the print environment. There is a lack of standardisation and best practice guidance in the textile printing industry over the use of ICC profiles in DTP. The research recommends that profiles are developed specifically for DTP which can incorporate data on variables particular to textile substrates such as weave, fibre type and textile chemistry.

Altering Colour Management processes

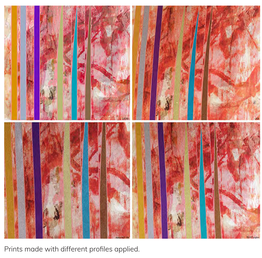
In addition, a number of experiments were conducted which altered colour management processes. The research practice displayed here forms a body of work visualising the impact of colour management on colour outcome. Print examples displayed here show the outcome of requesting no colour management be applied when sending a file to print. This primarily affected magenta and red hues which have increased in saturation. There is a slight impact on cyan and yellow tones where saturation conversely has decreased. Darker colours and greens seem relatively unaffected. Further tests looked at printing colours flagged as unprintable by APCC to see how they were reproduced. In addition, the research studied colour management processes such as linearization and profile maker software. A set of indicator and experimental profiles were developed as a consequence and are displayed here as in the Methods section.

Multi Pass Prints

Digital Textile Printing creates a print in a single pass, unlike traditional screen or rotary prints which prints colour in layers. The print head travels across the fabric depositing cyan, magenta, yellow and black colourant in a matrix of tiny dots to produce what is perceived as a full colour print, a technique invented by JC Le Blon in the early Eighteenth Century. An experiment was conducted where several designs were printed in multiple passes. The designs were separated into layers in APCC. A primary foundation layer was printed first and then the fabric fed back through the machine in order to print a second layer on top.

The first design has a simple flat background alternating each of the CMYK primaries as well as white and black. The second layer consists of set of coloured circles using the other primaries and black and white. A second design uses a tonal image which was loosely divided into four colour layers. The first two layers were printed together in the first pass, and the final two in a second pass. The scale of the second two layers was slightly enlarged to ensure that some overlapping would occur. A single pass print of both designs was made as a comparison.

The prints demonstrate colour differences between the double pass print and the single pass print, especially with deeper tones. For example, blacks appear richer in the multi pass print which is significant as black is notoriously difficult to print using CMYK colorants. However, paler colours such as yellows lose prominence as darker tones dominate or are lost when over printed. A number of fugitive colours form where the prints overlap which creates an interesting three-dimensional effect in the second design.



Prints made with different profiles applied.

The multi pass printing experiment was repeated using the second design printed in three passes. The darkest layer was printed first and subsequent layers scaled up in size to continue over laps of printed colour. This triple pass print has a quality of depth to the colour range, particularly the darker tones. Black areas appear brown where subsequent layers of lighter colours have been over printed. A single pass print was produced as a comparison.

The multiple passes build up colour due to an increase in dot density and dye application. However, the increase in dye usage introduces additional expense and may cause issues with over saturation, wicking and colour consistency. Digital textile prints can appear flat in comparison to textile printing methods that use pressure to apply layers of print paste. Therefore, multi pass printing might be used to enhance of deeper colour ranges or for the creative potential of including fugitive colours. This work follows on from research undertaken by Professor Carinna Parraman looking at the impact of multi pass printing on colour in paper printing.

These experiments explored several of the variables that impact colour to determine their impact on colour results. Profiles were shown to have subtle but clear colour differences when assigned to artwork. Whilst there are no current virtual device profiles specific for DTP designers should understand their purpose and consider which profile is appropriate for the print environment they will use. The research concludes that darker colours are perceived as richer when printed in several passes and that fugitive colours created by overlapping print passes offer artistic potential but would be challenging to produce economically viable or consistent prints suitable for the textile industry.

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The Development of Methodologies for Designers Engaging with Digital Colour Inkjet Printing in Textile Design

Becky Gooby, 3D3 Research Doctoral Student, Centre for Fine Print Research

Methods

A number of methods were generated through testing the variables which impact printed colour. These visual prompts are intended to support designers to build their own internal colour look-up table, enhancing their digital print colour knowledge, enabling them to predict and resolve colour issues during the design process. The outcomes presented are; a colour reference book, digital lap dip tests presented as colour maps, and a set of indicator ICC profiles, generated from data accumulated through measuring printed colour differences on a variety of substrates.

Detail of printed Pantone swatches

Colour Reference Book

To evidence that there is a difference between screen-colour and print-colour, and further variations between substrates, a colour chart was created, using the 1137 colours in the Pantone© solid uncoated colour library in Adobe Photoshop Creative Cloud (APCC). The chart was printed onto four different substrates (wool, linen, cotton and silk) using a digital textile inkjet Mimaki TX2-1600 printer, with reactive dyes (Cyan, Magenta, Yellow, Black, Light Cyan, Light Magenta, Red and Blue).

These fabric swatches were compiled into a colour reference book displayed here alongside full cloth prints of the Pantone range with a paper print as a comparison. Each swatch has the corresponding numerical values (RGB, CMYK, HSB, Hex and LAB) and a paper print, as the closest visual match to the screen-colour. The book provides a broad range of colours and data for comparison. The differences between screen-colour and printed colour, as well as between substrates, are evident. This is particularly clear in neutral ranges such as greys, blacks and browns, and colours from the blue and magenta tonal ranges. Several swatches were enlarged and reprinted after initial visual assessment to observe colour differences on a larger scale. These are displayed alongside a paper print for comparison.

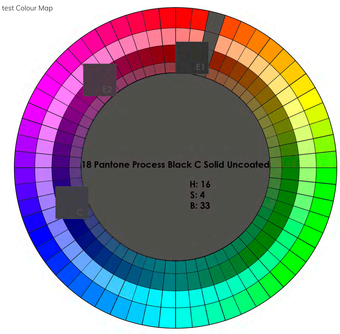
Example page from Colour Reference Book

Initial analysis revealed that 227 of the 1137 colours were considered out of the printable gamut of a generic CMYK printer. This was determined by APCC's out of gamut warning in the colour picker tool. The majority were from the magenta tonal range (53 purple and 38 pink), whilst 46 were classified by the researcher as green, 27 red, 21 blue, 20 yellow, 20 orange and 2 brown. Some colours which were flagged as unprintable, had a better than expected colour match. For example, shades of warm reds and oranges were flagged, yet are a close visual match to the screen colour. Swatches of neutral greys differ greatly from screen colour but were not flagged. This discovery highlights how colour tools may cause further confusion about colour results.

Data analysis established that a hue with a high red RGB value, 229 and above, would be likely to be out of gamut for a generic CMYK printer. Colours with a hue HSB value between 252 degrees and 288 degrees, the blue to magenta range, were also likely to be considered out of gamut. Likewise, bright colours, with a brightness HSB value of 80% and higher, would be likely to be considered out of gamut.

The research envisages that the Colour Reference Book, as part of an online colour toolkit, could be used to look up hues in order to get a sense of how they might print upon different substrates. Currently Pantone offer colour system swatches printed onto Cotton, Nylon and Polyester but not Silk, Wool or Linen and the swatches are dyed rather than printed. Several DPBs such as Spoonflower have colour charts that you can pay to print on your choice of substrate with corresponding digital colour data. Spoonflower allows users to upload designs which customers can select for printing. A search of these user designs show several colour charts recommended as designer reference tools. These have positive reviews supporting the idea that this form of colour tool is helpful and aids colour expectation and assurance.

Example of a Digital Lap Dip test Colour Map



The Colour Reference Book demonstrates that achromatic colours and hues with a high magenta or blue tone are problematic and will require careful colour testing. Therefore, designers may wish to consider how they use th ese colours within a design.

Digital Lab Dip Tests – Colour Maps

A series of indicator colour maps were produced using mean averages of hue, saturation and brightness (HSB) value shifts for a set of colours. These colour maps are presented here as A1 paper prints. Digitised swatches were plotted onto the colour maps to visualise printed colour changes from the screen colour. The digitised swatches symbolise a digital lab dip test and illustrate how a colour might shift when printed onto different substrates. A lab dip is the term for a fabric sample used by the manufacturer to establish a colour match with the buyer's supplied swatch or colour standards. The maps offer visual prompts to allow designers to build their own internal colour look up table, enhancing their digital print colour knowledge and enabling them to predict and resolve colour issues during the design process.

The data was obtained through measuring two sets of printed swatches in the colour reference book. Set one consists of prints from the first 24 Pantone© colours to represent a comprehensive range of highly saturated, spectral hues (red to purple). Set two is composed of colours from a colour rendition chart. Rendition charts are made up of key test colours such as RGB and CMYK primaries, a greyscale and colours found in nature, for example sky blue.

The swatches were measured using a Kodak-Minolta FD-7 spectrodensitometer which returns sophisticated colour measurements using filters to measure the wavelengths reflected from the colour sample. The spectrodensitometer was set up to measure the reflectance value under D65 illuminant conditions, the standard for measuring textiles, and return CIE LAB, the mathematical model of human vision, and wavelength (nm) values from 380-730nm. The LAB coordinates were entered into the colour picker tool in APCC to display a digitised version of the printed swatch, representing a digital lab dip test.

Finally, the corresponding HSB value was recorded so that the numerical data could be compared. The use of the HSB colour model allowed simpler average comparisons to be made which were more of a challenge to calculate using the LAB model. Each map is a 360-degree hue colour circle that has inner rings decreasing in saturation and brightness. The digitised swatches show the clear reduction in saturation and brightness to be expected when printing on to fabric and some discernible differences in hue.

A complementary map representing an overall colour expectation shift was also produced. An average HSB value was taken using the measurements of all substrates for Set One, and the resulting colour and values placed at the circle's centre, encompassed by the screen colour. Set Two has two overall colour shift expectations, centre circle and encompassing circle, using median data from two data sets, one which includes wild card values and one without. These secondary maps offer an immediate idea of expected colour changes to designers by juxtaposing the screen colour with an average, anticipated print colour.

Colour Mimix Colour Checker Chart by Phil Henry

The maps reveal that detailed colour testing and adjustments will be required to obtain satisfactory colour matches, particularly for prints on Wool, Silk and Linen. Blacks, magenta tones and cooler blues and greens demonstrated the greatest hue shifts and changes to saturation and brightness, supporting analysis from the Colour Reference Book.

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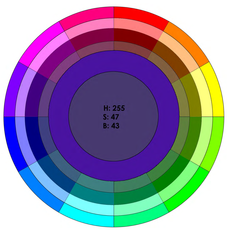
Methods (continued)

A set of Digital Lop Dip test Colour Maps

These diagrams demonstrate the gamut mapping process by visualising the shift from the input colour range on screen, to that of the printed output colour space. Gamut mapping is the recalculation of hue values to transition from one colour space to another. Converting pixels of light on screen to printed dots of colour involves considerable colour modifications. The methods applied are known as rendering intents. A rendering intent will prioritise certain colour qualities over others, depending on the desired image outcome. They have been developed for enhancing prints on paper and subsequently do not account for textile substrates. A specific rendering intent has not been developed for printing onto textiles. It is likely that a designer will not even be aware of the rendering intent used by the DPB nor their purpose and impact on colour outcome. The fabric prints tested as part of this research used a perceptual rendering intent which is the standard gamut mapping method used in UWE's Digital Print Bureau.

The research findings from these investigations determine that the substrate has a great impact upon colour outcome. Visual analysis of all four substrates compiled in the Colour Reference Book demonstrates poor colour fidelity for neutral and achromatic colours (browns, blacks, pastels and greys) and that there are further issues with colours with a magenta or blue undertone. In general, the digital lab dip tests demonstrate differences in saturation and brightness from screen to print. On average printed colour decreases between 10-20% and shifts clockwise around the hue circle from 2-25 degrees. These differences are visualised as colour maps which support designers' colour expectation knowledge in order that they might confidently gauge printed colour results.



Example of second complementary indicator colour map

Indicator ICC Profiles

A set of prints were made to observe the changes to the overall appearance of an image by assigning different virtual device profiles to a specifically created colour test collage. Consequently, the research considered whether a profile could be created which indicated to the viewer the colour alterations to expect when printing onto different textile substrates.

These profiles were developed using the existing data from measuring the Colour Reference book. The aim was to provide an indication of expected colour changes to a designer viewing their image on a computer display, allowing them to make adjustments to obtain a better colour relationships and balance prior to printing. The profiles are represented here as an A1 paper print.

Profiling is a means of comparing measured reflectance data, from RGB (red, green and blue) or CMYK colour ranges, produced by a particular device or devices, with known reflectance data from International Colour Commission (CIE) models. ICC profiles were developed by the International Colour Commission (CIE) in 1993 as an open profile format which could be used universally across different software and devices.

Data is stored in a look up table, used for mapping an input to an output value, to provide information about numerous colour possibilities. Profile maker software uses a colour target to gather information about the device's colour reproduction. A colour target is a set of colour swatches which range in number depending on the software used and user selection. The target is measured and the returned data is used to provide an overview of colour options for the look up table, limiting the amount of data to be stored.

Colour Management processes such as profiling and linearization have been developed to maximise a device's achievable gamut. Both these processes use data from the print environment to optimise the print outcome. Linearization uses colour measurement data to ascertain the optimum media (colorant, substrate etc.) settings. Whereas a profile is like a colour recipe, used to transfer data on colour construction to output devices. This aids conversions between RGB pixels of light and solid CMYK dots of colorant.

Indicator profile for wool applied to colour collage with virtual device profiles for comparison

Both processes require access to colour measurement devices such as a spectrophotometer and specialist software which are expensive and require training for use. At the moment neither process allows you to store information particular to textile substrates, such as the type of textile chemistry pre- and post- methods, weave or fibre type which impact colour outcome. These processes were developed for reprographic and photographic printing where the colorant will sit on a smooth, non-woven, surface which doesn't require fixation other than air drying.

It would be expected that a DPB service would carry out colour management procedures. They may recommend that supplied artwork be assigned a particular ICC profile, generally a virtual device profile, for example Adobe RGB 1998 or sRGB IEC61966-2.1, which have been developed for general colour management use. However, these profiles provide a false idea of colour reproduction possibilities as their gamut boundaries are far wider than the colours achievable using CMYK colorants.

An analysis of profile creation software was conducted to determine whether it was possible to edit profiles as well as generate them. However it was quickly established that the software was complicated and not possible to learn within the timeframe of the research project. Consequently, a more creative option was taken. The colour targets were directly altered in order to modify the information returned to the profile maker software and create speculative colour look up tables.

To create the indicator profiles a colour target, consisting of 1748 swatches used by Printer Cal, profile maker software for AVA CAD CAM, was repeatedly modified in APCC. AVA CAD CAM is a specialist software for textile and decorative surface designers and producers. The modifications were made using existing data and focused on HSB shifts for different substrates as well as red/blue wavelength adjustments and greyscale calculations. The targets were printed onto Cotton Satin and measured. Next, the data was returned to create ICC Profiles using Printer Cal software. Finally, the profiles were assigned to the specifically created colour test collage image in APCC to observe the colour changes on screen.

Six colour collages images were examined; four images with assigned indicator profiles modified using data on hue, saturation and brightness shifts for four substrates (wool, linen, cotton, silk), and an additional two, using assigned standard, Virtual Device ICC profiles (sRGB IEC61966-2.1 and Adobe RGB 1998) as comparisons.

Wool

The image has a slightly orange appearance which is most noticeable in the neutral colour ranges. The colours appear muted in comparison with the images assigned with standard generic profiles. Colours from the blue/magenta tonal ranges are most vivid and green tones appear bluer. The neutral ranges has a soft contrast and appears to have a sepia like appearance.

Linen

The image has a slightly yellower appearance which is most noticeable in the neutral colour ranges and in the red tones. Blue and green tonal ranges appear yellower. Neutral tones have a strong contrast but instead there is a loss of tone quality.

Silk

The image has a slightly magenta appearance which is most noticeable in the neutral colour ranges. The red tonal ranges appear strong and spectral colours are saturated. Neutral ranges appear darker than the linen or wool images, with a strong contrast.

Cotton

The image has a slightly orange-red appearance but neutral ranges do not. The colours are strong and saturated similar to the silk profile except that there is improved tonal quality and decreased contrast which achieves a better colour balance.

sRGB IEC61966-2.1

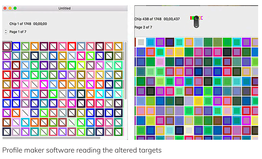
The image has strong saturated colours in comparison to the indicator profiles with no apparent overall colour tint. The neutral ranges have a slight green quality to them but contrast, tonal quality and colour balance are all good.

Adobe RGB 1998

The image has incredibly strong saturated colours, particularly in the blue tonal ranges, in comparison to the indicator profiles with no apparent overall colour tint. There is strong contrast but a lack of tonal quality. The neutral ranges have no apparent colour tint.

All indicator profiles demonstrated a loss of brightness and saturation in comparison with the standard, generic profiles which is in keeping with the reduced brightness and saturation appearance of printed textiles.

These results had some correlation with the findings of visual analysis of differences from screen to print colour using the Colour Reference Book. Linen, a cellulose fibre constructed from flax plants, does not absorb dye particularly well. The juniper linen tested has the loosest weave of all four substrates and whilst colour matches on Linen appear good, the saturation is greatly reduced. Wool is a keratin protein, animal fibre which naturally repels moisture but does absorb dyes. However, whitening pre-treatments are complex and Wool substrates prepared for DTP tend not to be bleached in order to reduce costs. The Wool substrate used in this research is in its natural state which has a yellow undertone affecting the printed colour. Similarly, Silk is an animal fibre and absorbs dye well. The smooth texture and reflective qualities of the Satin Silk tested provided strong colour results but darker than the screen colour. Cotton is cellulose, derived from cotton plants, but absorbs and retains dye well. Like the Silk, both the Linen and Cotton were bleached white in the preparation for print.



Profile maker software reading the altered targets

The resulting profiles offer a visual indication on screen to designers of the overall colour shifts that may occur when printing onto different substrates. This improves the designer's colour knowledge and prompts colour resolution practice at the design stage, prior to hard proofing, saving time and reducing costs.

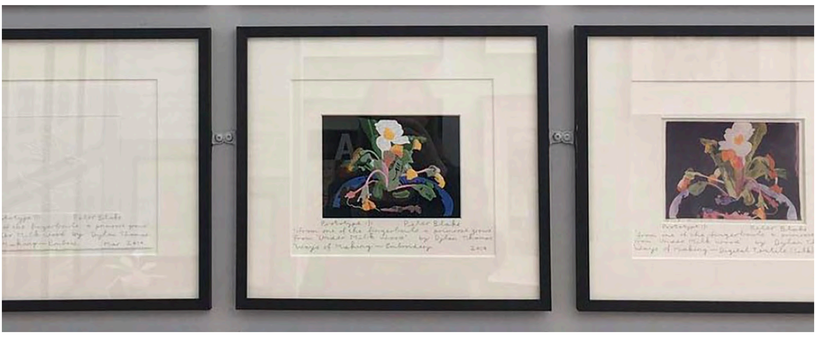
The results are subtle and not as apparent as some of the variations in the Colour Reference Book. Colour differences can be obscured when viewed within an overall design as opposed to separate swatches. Yet a designer used to gauging colour changes can utilise the indicator profiles to detect which colour ranges may need adjusting when choosing an end substrate.

The Development of Methodologies for Designers Engaging with Digital Colour Inkjet Printing in Textile Design

Becky Gooby, 3D3 Research Doctoral Student

Case Study: The Ways of Making Project

A number of prints were made for the Ways of Making Project which applied knowledge developed through the research inquiry; indicator profiles and multi pass printing. The experiment set out to explore the creative potential of DTP through the application of experimental profiles and multipass printing. The application of the experimental profiles in particular aimed to transpose colour fidelity by deliberately altering colour data so that it would not achieve a correct colour match to the image seen on screen.



Digital textile print of Blake's Primrose on display at London Original Print Fair, Royal Academy

The Ways of Making Project is a collaborative project between Sir Peter Blake, Worton Hall Studios and CFPR, UWE. The aim was to create an archive of every known medium, exploring edition making through creating multiple versions of an image through a variety of processes. The project brief asked researchers to reinterpret Blake's visuals through their print discipline, drawing upon their particular knowledge and skill set.

Consequently, a number of digital textile prints were made which modified Blake's visuals through the application of ICC profiles developed by the researcher. In addition, several multi pass prints and two pattern repeats were produced, printed on silk satin.

A series of profiles were applied to eight different images of a primrose, producing forty prints. The profiles altered the colour data to create experimental colour modifications.

The prints were observed and reflections recorded.

Experimental Profile Red Blue applied to Blake Image

Multipass Print of Blake Image

Adobe RGB 1998: Virtual Device profile

A generic, standard profile developed by Adobe to maximize the potential for CMYK (printer) colorants to capture as many of an RGB (screen) saturated hues. Prints are bright and colours vivid.

Experimental Profile 1: Red-Blue Profile

Digital fabric prints were shown to reflect a greater amount of higher, red wave-lengths, and absorb more of the lower, blue wavelengths, than digital prints on paper, altering colour perception. A pro-file was developed using data which ex-amined these differences in reflected and absorbed spectral wavelengths to adjust the red and blue balance of a profile tar-get. The resulting profile produces deeper blacks, deepens blue hues and shift reds towards magenta tones and yellows to-wards green.

Experimental Profile 2: Silk Profile

Silk satin is highly reflective and finely woven fabric which produces vibrant, printed colour. Silk fibres absorb dye well promoting colour saturation and can yield brighter than intended, brash colours. A profile was created using the measured Hue, Saturation and Brightness differ-ences between screen and printed colour swatches on silk and applied to a profile target to reduce the potential for colours to appear garish. The resulting profile produces strong colours which have a warm blue undertone, whilst blacks and neutrals have a softer appearance.

Experimental Profile 3: Grey Profile

Grey profile – CMYK prints create grey-scale by printing equal amounts of cyan, magenta and yellow dots, which theoreti-cally should be perceived as tones of grey. However, spectral quality issues with cy-an colorants lead to a magenta domi-nance in colour perception, resulting in pinkish greys. A profile was developed using measurements of the differences between screen and print hues in the greyscale range. These were applied to a profile target, radically altering the measured target colour set, and conse-quently the profile. The resulting profile produces saturated, pink images with fuzzy tonal and image quality. Large grey-scale areas have a shimmery appearance.

Experimental Profile 4: Grey Profile Two

The grey profile was applied to the image set after greyscale conversion, discarding all original colour information. This pro-duces a subtler effect with an overall cooler, colour temperature.

Additionally, two types of multi pass print were made. DTP creates prints in a single pass unlike traditional screen or rotary prints which are printed in colour layers. The print head travels across the fabric depositing cyan, magenta, yellow and black colorant in a matrix of tiny dots to produce what is perceived as a full colour print. The prints, a layered method which printed key colours as separate layers, and an overprint, where the primary palette was re-printed on top of a single pass print, were observed to have a visual 3D effect (Figure 16).

Multipass print One: Colour Separation

Red, Blue, Green and Yellow hues were removed from the digital images to create two separate layers. The first layer of primarily neutral greyscale tones was printed and a second layer containing the red, blue, green and yellow tones printed on top. The resulting print has a 3D effect and a hazy quality.

Multipass print Two: Overprinting

A full colour print was made of the set of images. The print was then overprinted with a second layer consisting of only the red, blue, green and yellow hues. The resulting print has a 3D effect and deeper, stronger coloration.

Finally, two pattern repeats were generated using one of Blake's primrose paintings as a motif.

The silk profile print was exhibited at the introductory Ways of Making exhibition held by Worton Hall at the Original London Print Fair, Royal Academy London in April 2019. The remaining prints form part of the archive and wider body of work which will be exhibited internationally alongside publications about the project. The production of these prints presented a means of applying colour knowledge, developed by the researcher, to demonstrate the creative and exploitative potential of digital textile printing. Colour management processes use mathematical models and scientific theory to convert pixels to dots to produce perceived colour ranges. Algorithms are automatically performed out of sight and seemingly with little input from the user. Yet in this instance the technology was harnessed to produce aesthetically interesting and experimental colour outcomes retaining designer creativity. The Ways of Making project was initially inspired by visit to an art college where Blake became concerned with the usurpation of many forms of craft and hand skills by computer usage. This work demonstrates that a designer may exert control in the realm of digital colour printing by manipulating computer algorithms, preserving the designer's eye as ultimate colour control.

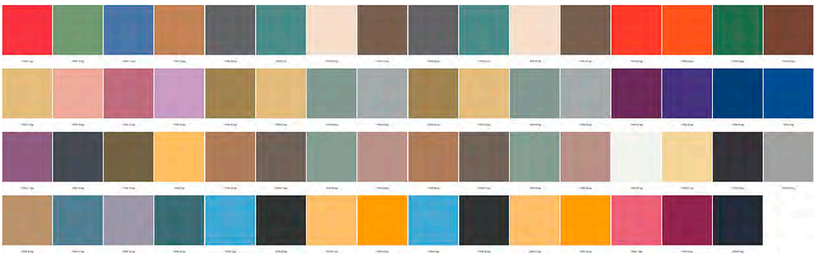
Repeat pattern design printed onto silk using Blake Image

The Development of Methodologies for Designers Engaging with Digital Colour Inkjet Printing in Textile Design

Becky Gooby, 3D3 Research Doctoral Student

Case Study Interwar Colour Archive

This Case Study observed colour use in textile design during the British Interwar period to create a body of work as a real world test case for the three key methods, developed by the inquiry, Colour Reference Book, Digital Lab Dip Tests and Colour Maps, and Indicator Substrate Profiles. In addition, the study looked at the economic, societal, cultural and technological changes that impacted upon textile design in particular new printing technology, fabrics and dyes during this era to consider whether any lessons might be learned for best practice guidance in DTP.



1930s Colour Palette created using Pantone Historical Colours book.

The British Interwar period was a time of great textile technological modernisation, change and innovation, with the advent of cheap, chemical colorants, synthetic fabrics and the emergence of silk screen textile printing. Britain's house building boom and increased availability of mortgages meant that homeownership and interior decoration were made available to the masses. New modernist concepts of sleek and neutral interiors emerged alongside a brightly coloured 'Moderne' or Art Deco palette, creating a distinctively British 'look'. This contrasted with a darker Victorian and Edwardian palette that also continued. Colour creation entered a chemical sphere with the introduction of bright colours that came with them.

A particular colour palette was identified from examining textile samples from the period through archival research, alongside secondary research, to produce a body of design work. Many of the colours associated with the fashions of the 1920s and 30s, smoky, dark colours, neutrals and strong earth colours, have been proven to be the hardest to replicate in DTP. The resulting body of work was used to test the three methods developed by the research inquiry, the results of which were documented and recorded.

The exercise set out to compare the development of colour use in textile design during the Interwar period and create a body of colour work to test a number of methods developed by the inquiry.

Colour Sampling at Crysede archive

Ushering in Technological Change

The period after the First World War saw huge economical and societal changes. A house building boom and the introduction of mortgage loans made available homeownership, and therefore interior decoration, to much of the British population. The middle classes were on the rise with money to spend in the new department stores on furnishings and ready to wear clothes. Commercial CMYK paper printing, developed in the previous decade, reduced the cost of colour prints which allowed the public to see accurate, colour images in the new home decoration and fashion journals, influencing taste and style. The first colour forecasting and trend agencies were set up to inform manufacturers on consumer tastes. A British 'look' emerged, a more colourful version of continental modernist trends. Organisations such as the Design and Industries Association and the British Colour Council sought to champion 'good' design standards in partnership with industry innovation, a modern follow on from the British Arts and Crafts movement.

Colour creation entered a chemical sphere with the introduction of bright colours that came with them. The bolstering of the British Chemical industry by the formation of British Celanese Ltd in 1912 and Imperial Chemical Industries (ICI) in 1926, benefited by the decrease of production in Germany post First World War. Protectionist economics saw the implementation of a general tariff of twenty percent on manufactured imports in 1932 increasing sales of British textiles within the home market and furthering businesses like Warner and Son who took advantage to grow their fabric printing business by incorporating a screen print workshop, producing their first silk screen print "Shubbery" by V Muller in 1931. A huge number of women, whose male counterparts had been killed or maimed in the war leaving a surplus of unmarried women, turned to work with textiles and interior decoration, deemed suitable jobs for women. Artists turned designers in order to generate income in a time of economic instability, with Allan Walton Textiles, Edinburgh Weavers and Omega Workshop championing artist led design. The employment of freelancers, predominantly women, gave manufacturers the opportunity to test out modern designs, without having to provide financial commitment. The British Colour Council, established in 1930 by Robert Wilson, responded to a need for standardisation, producing a Dictionary of Colour Standards for the textile industry.

Eileen Hunter fabrics laid out at The Clothworkers

In 1931 the International Commission on Illumination (established in 1913), defined the CIE XYZ colour space, a revolutionary mathematical model of the visible spectrum. Le Corbusier's desire to control colour for his vision of 'polychromie architecturale' led to the creation of his colour harmony selections, 'colour keyboards', and coloured wallpapers which ensured he maintained control over the colours within his designs, a step away from builders mixing up paint from powder on site which could lead to colour discrepancies. In a survey of colour trends of the period, Derek Patmore wrote 'once the rules of colour have been mastered, the decoration of the home need not be expensive or ugly '. The principles and rules of colour had never been more widely studied or available.

An initial survey of research on the British Interwar period established a number of key, accessible archives to visit including the Victoria and Albert Museum (V&A) archive and Transport for London's Acton Depot which holds the moquette seating collection. Further research uncovered Eileen Hunter, a freelance textile designer working in the 1930s and whose archive is held by the V&A. A visit was made to the Crysede archive in Cornwall, a high end fashion house from the English Riviera's Jazz Age.

Crysede

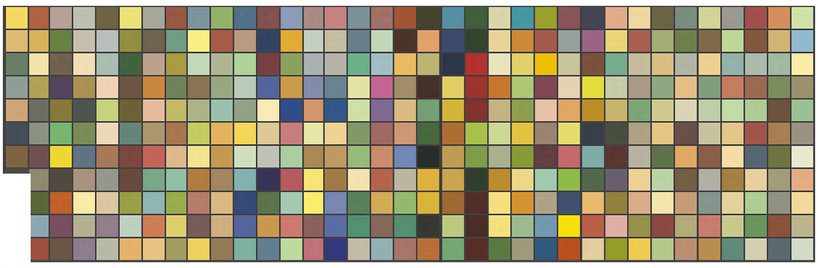
Crysede produced high end fashion pieces in the midst of the modernism of the 'Cornish Colonies' in the 1920s. Outside of London, this arts and craft movement was concentrated around the activities of the St Ives School and Newlyn School of painting. The designs were illustrative and influenced by textile designs of Raoul Dufy and Paul Poiret. The dyes were British synthetics, bright and colourfast.

The archive holds several colour sample sheets, some on coloured grounds (blue, red, yellow-brown, green-white) with rows of coloured circles starting with the standard dye colour and then lighter mixes of the hue with notes on the proportions. Some of the colour names are very evocative of the 'moderne' era, for example Tango, New Flame, Picasso.

Moquette Sample at London Transport Acton Depot

A number of colour studies were made based on photographs and sketches and used to create a Crysede Colour Palette, rich with strong earth colours and bright hues which was applied to an illustrative design, inspired by the Bristol landscape.

Case Study Interwar Colour Archive (continued)



Colour Palette derived from Anatomy of Colour paint charts

Transport for London Moquette fabrics

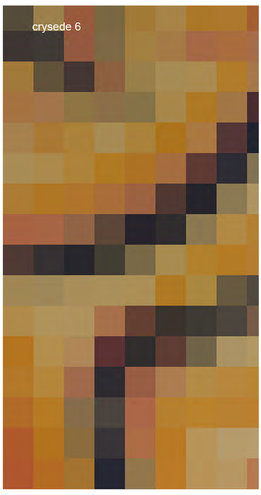
The Managing Director of London Underground in the 1920s was Frank Pick, a leading medieval modernist who founded the Design and Industries Association and subsequently the Council of Art and Industry in 1934. Pick commissioned much of the now iconic branding for the tube. His favourite colour was green and the colour palette for the moquette fabrics used to upholster the tube seating was primarily green and red. Dissatisfaction with stock moquette prompted Pick to employ prominent designers Paul Nash, Enid Marx and Marion Dorn to create bespoke designs.

The designs were primarily dark colours with accents of bright red and light green. Many of the designs were tonal using a dark and mid tone of a colour such as green, pink, brown or blue with an accent colour. It must be presumed that there will have been some colour fading due to the age of the fabric samples.

A number of colour studies were produced using photographs and sketches and used to produce a colour palette of strong, dark, earth colours, forest green, sage green, dusky pink and chocolate brown and accent highlights, red and sky and navy blues and applied to several geometric designs.

Eileen Hunter Archive

Hunter donated her archive to the Victoria and Albert Museum but the fabric swatch books were not available for viewing because they were on loan. Hunter was a freelance textile designer in the 1930s designing for soft furnishings and interiors. Some of the designs had names such as Apollo and Cornucopia but most had a numerical reference. Hunter's colours were bold using strong emerald green, tonal pinks, marine blue and purples. Hunter was unusual in that she set up her own textile studio rather than working freelance. Boydell classifies the 1930s as the rise of the female freelancer where design studios began to buy and commission freelance designs primarily because it was more cost effective. Freelance work did not pay particularly well and Boydell writes that Hunter set up on her own to maximise her income.



Colour study made after Crysede archive visit

Several designs were created inspired by Hunter's illustrative style and printed in several colourways using a colour palette derived from examining paint sample collections from the interwar period and Pantone's guide to historical colour use.

Further Material

In addition to the archive visits the inquiry sought to examine material related to Interwar period through visits to exhibitions and reviewing primary and secondary textual sources including Pantone's History of Colour and Patrick Batty's Anatomy of Colour and the work of Colefax and Fowler, society decorators and the Omega workshop, artists turned designers.

Method testing

A sample of each colourway for every design was printed onto the four test substrates (wool, linen, cotton and satin) and compiled into two sample books. Visual analysis of the fabrics was conducted and the books were annotated with observational comments.

Twenty colours from these prints were identified as the most problematic, reducing the number of colours to consider. These colours were translated into the closest Pantone reference match using the colour picker tool in APCC. It became apparent that several of the colours were very similar, reducing the colour set to 14. The colours ranged from dark earth blues and greens, a range of neutral achromatic colours, strong earth reds and yellow and a number of paler purples and magentas.

Example of Digital Lab Dip tests and Colour Maps for problematic colour set

Colour Reference Book

The printed designs were compared with the corresponding swatches in the Colour Reference Book to see whether an examination of the individual swatches would have identified that these colours would have been a challenge to print. The observations recorded and documented. Several of the Pantone colours were considered to be a poor match for the original challenging colour highlighting that algorithmic conversions between colour spaces can be problematic. Therefore of the 14 in the challenging colours set only 6 of the Pantones were close matches to the original set of 20 identified in the sample book. This 6 was taken forward to the next stage of testing. The colour set consisted of a dark earth green, light earth green, dark grey, strong earth red, bright pink and a pale earth yellow and the corresponding swatches in the book closely resembled the colour outcome in the printed samples, supporting the book as a useful reference tool.

Digital Lab Dip Tests and Colour Maps

A digitised lab dip test was created for these 6 colours, 1 per substrate, measuring the corresponding swatches in the Colour Reference Book with an Xrite I1 Spectrophotometer returning LAB data. The digitised swatches were plotted onto the Colour Map template, consisting of four swatches per colour. A complementary colour map with an indicator colour was also created using mean average data. Of the 6 hues, 4 offered a good indication of how a colour might print in comparison with the printed samples and swatches, and 2 did not. All of the swatches showed a loss of brightness and saturation and a movement in hue value, in line losses in the initial colour map exercise. The 2 colours whose indicator map was not a good match to print outcome, were the dark grey and the bright pink. The pink swatches, Pantone 5155, had considerable hue value differences to the screen colour.

Indicator Substrate Profiles

Finally the four different indicator substrate profiles were applied to all fourteen designs from the problematic colour set. The differences on screen were next compared with the printed versions to determine whether there was a considerable likeness proving the indicator profiles to be a suitable proofing method. The observations were recorded and documented. When the profiles were applied to 9 of the designs, visual analysis indicated that the profiles were a good indication of the impact a substrate had on print outcome. 5 of the 6 colours taken forward to the mapping stage also demonstrated that the indicator substrate profiles were a good indication of print colour outcome. The pink hue, Pantone 5155, had a good tonal match but not hue match on screen to the printed outcomes. The other 4 designs were from pink, red, green, yellow and brown colour ranges and therefore similar to the 5 mapped colours. The indicator profiles did not offer a good indication of print colour across substrates on any of the blue, purple or pale achromatic colours.

Analysis

Colour Reference Book

Colour conversion issues between software (AVA to APCC) and colour spaces (LAB to Pantone) made it difficult to assess a broad range of colours from the challenging set. However the 6 that did appear a close match to the corresponding Pantone reference additionally demonstrated a clear match between the swatches and the samples.

Digital Lab Dip Tests and Colour Maps

Likewise only 6 colours were tested and of these 4 demonstrated that the indicator colour was a good match to the printed colour outcome in the samples and swatches.

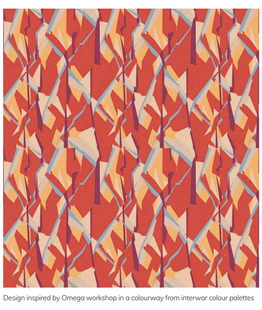
Indicator Substrate Profiles

Whilst 9 designs demonstrated that the indicator profiles were useful for proofing, 5 were not. These 5 had challenging colours from blue, magenta and neutral achromatic ranges which had previously been highlighted as particularly challenging to print.

Summary

The reduction of the colour set due to the conversion issues meant that a broad range of blues, magentas and achromatic colours were not able to be analysed as part of the Colour Reference Book or Digital Lab Dip Colour Mapping tests. Colours that were tested demonstrated that both these methods could be useful, although there were some anomalies. The indicator substrate profiles additionally appeared to be a useful proofing tool but not for all colour ranges. Likewise further work would be required to support print colour knowledge around some of the more trickier to print ranges such as blues, magentas and neutral achromatics.

Designers from the British Interwar era talk of the rigour required to meet manufacturing concerns as well as the excitement of the marvellous machine. Digital Textile Printing has introduced a similar change to the production of printed textiles. Designers need to understand the DTP process in order to achieve a comparable rigour and aesthetic design language using this new technology. However best practice guidance is lacking and design education in DTP is emerging. Industry organisations such as the Design and Industries Association produced guidance and standards that could be utilised by designers and manufacturers alike and this is currently missing from guidance on DTP. This inquiry would recommend that trade and industry bodies such as the SDC, ASBI and UKFT seek to produce DTP guidance in order for this technology to continue to develop.



Design inspired by Omega workshop in a colourway from interwar colour palettes

This case study has been an interesting comparison with another era and provided a solid body of colour work for testing.

Appendix D
Reflections on Praxis Work

This appendix presents a reflective journal documenting observations of the practical work undertaken during the research project – Years 1, 2 and 3

Becky Gooby

Research Practice

Year One

Crafting Colour: The development of methodologies for digital colour printing in textile design, through an understanding of interwar historical colour palettes

Colour Profile Experiments

Three prints were made using different colour profiles assigned in Adobe Photoshop

The profiles selected were

- Adobe RGB 1998 (colour profile used by technician when sRGB… doesn't prove a good colour match)
- sRGB IE661966-2 1 (colour profile most frequently used by technician to get best colour results)
- PowerPhase FX with TG1 Tungsten (original file profile)

Adobe RGB 1998

sRGB IE661 966 – 2.1

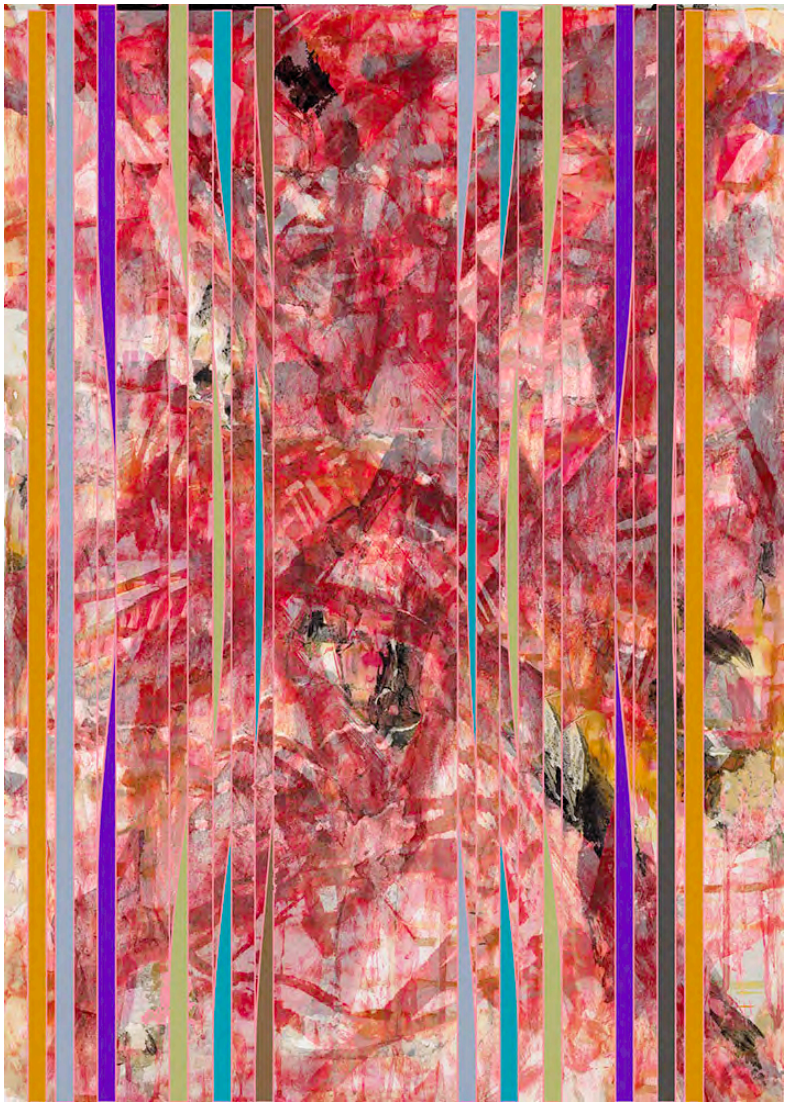
PowerPhase FX

Detail of print

Adobe RGB 1998

sRGB IE661 966 – 2.1

PowerPhase



Original Artwork

All three colour profiles (L-R) Adobe RGB 1998, PowerPhase, SRGB

Observations

- There are very subtle colour differences
- The PowerPhase profile is the brightest, the reds appear bluer and there is a greater , sharper contrast between white / lighter areas and coloured areas (reds)
- The sRGB profile offers the warmest colours, even the yellows feel warm and not blue. The tonal range is very pink tainted and the dark colours (silver stripe, dark grey stripe) appear muted
- The Adobe RGB 1998 profile looks bluer than the sRGB but not as bright as the PowerPhase.

Additional Information

- The file was chosen because it covered the warm red tonal range which I have found hardest to colour match
- The PowerPhase colour profile was not selected for this file but must have been assigned by Adobe Photoshop as part of the design process, possibly as the original artwork (created by the researcher) was photographed professionally and then the digitised files worked on by the researcher
- All three colour profiles were printed on cotton satin using a Mimaki printer and photographed inside in daylight using a Nikon SLR camera

What next

- Annotate the prints, circling the areas that I feel show the biggest differences
- Make observational comparisions between the profiles and the artwork
- Research the colour gamuts of each colour profile and find out more about each profile's characteristics
- Compare the colour gamut of each colour profile and discuss how these affect the colours produced, and why they might be the cause of the differences observed

Colour Collage

- A collage was created by the researcher which represented a range of colours using scanned images and items, digitally created designs, photographs and colour charts.
- This collage was then printed using an Epson Stylus DX400 printer, which uses Durabrite pigment inks, onto a neutral coloured polycotton and paper.
- Each print used a different colour profile assigned in Adobe Photoshop
- The colour profiles selected were the top 8 most common colour profiles offered by Adobe Photoshop Creative Cloud. Each colour profile is listed underneath the photograph of the print.
- The photographs were taken inside in daylight by a Nikon SLR camera

Adobe RGB 1998

Apple RGB

Colour Match RGB

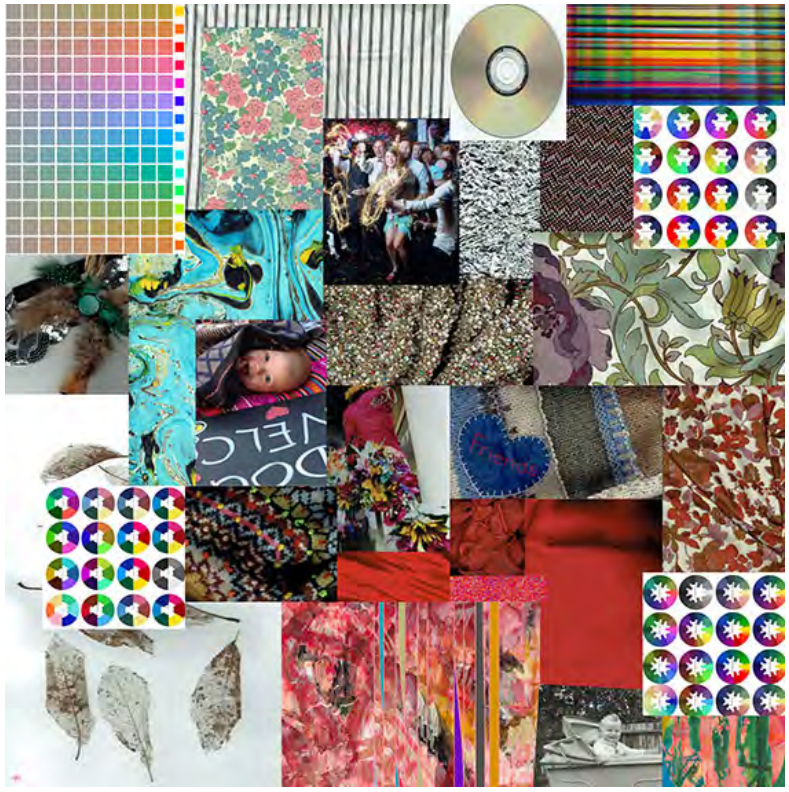
HDTV (Rec 709)

ProPhoto RGB

SDTV NTSC

SDTV PAL

sRGB IE661 966 – 2.1



Original Artwork

Adobe RGB 1998 Fabric & Paper

Apple RGB Fabric & Paper

Colour Match RGB Fabric & Paper

HDTV (Rec 709) Fabric & Paper

ProPhoto RGB Fabric & Paper

SDTV NTSC Fabric & Paper

SDTV PAL Fabric & Paper

sRGB IE661966 – 2.1 Fabric & Paper

Observations

- Most of the colour profiles offer subtle colour differences
- Some of these differences are only obvious when you look at details of the collage, for example how black and white tones are printed in the black and white photograph
- ProPhoto RGB offers the brightest, most saturated appearance but lacks distinctions between tone (particularly the red image mid centre bottom)
- Colour Match RGB and Apple RGB have a very similar apperance
- Adobe RGB 1998 appears crisper and has greater contrast in tones (light and shade)
- HDTV (Rec 709) appears muted and dull in comparison to other profiles
- SDTV NTSC has a faded yellowish tinge to all the images especially the photographic images and the reflective scanned images (tin foil and a CD)
- SDTV PAL similarly appears faded but with a blueish tint
- sRGB IE661 966 – 2.1 has a better contrast in tones (the purple william morris esq purple flower print middle right) but the detail of line (scanned skeleton leaves) isn't very clear. However there is also banding on this print as it was the last to be made so possibly printer issues.
- The paper prints also have banding on them but are clearer and easier to see and compare back to the original artwork. In hindsight I should have used white fabric to print upon rather than a neutral colour as this has affected the printed colours

Additional Information

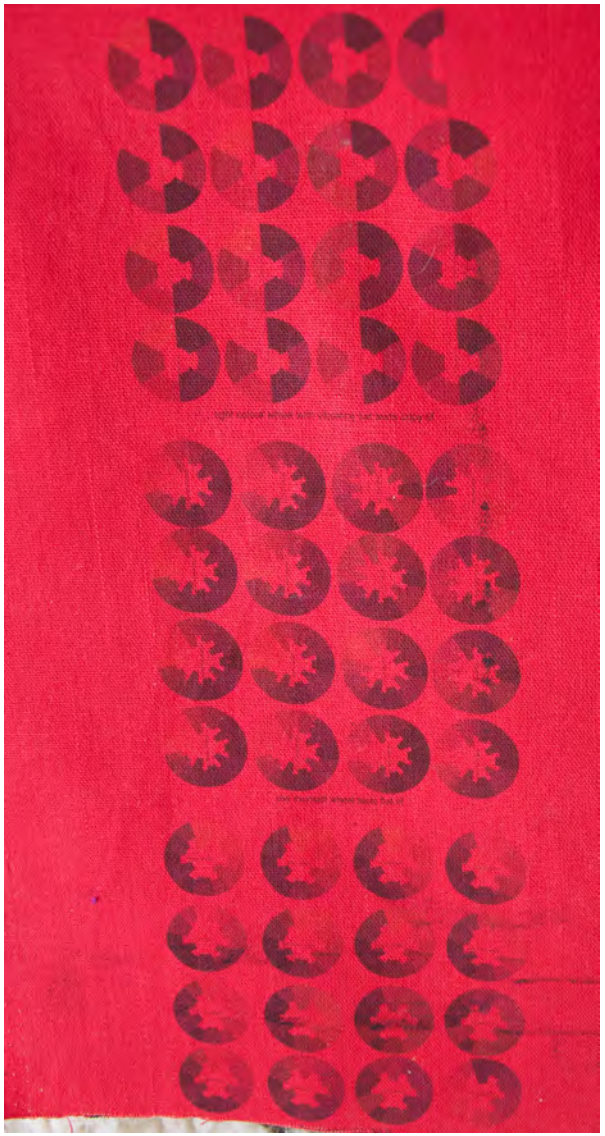
- This experiment was inspired by Prof Carinna Parraman's original experiment using Fine Art Papers, colour profiles and printer colour management in 2003

What next?

- re-print the colour profiles but on white fabric
- re-print the colour profiles but unticking the printer manages colours box in the print communication process
- Annotate the prints to show the differences between profiles and do a more detailed comparison to the original artwork
- Find out more about the colour profiles, what do they mean, what gamuts do they cover

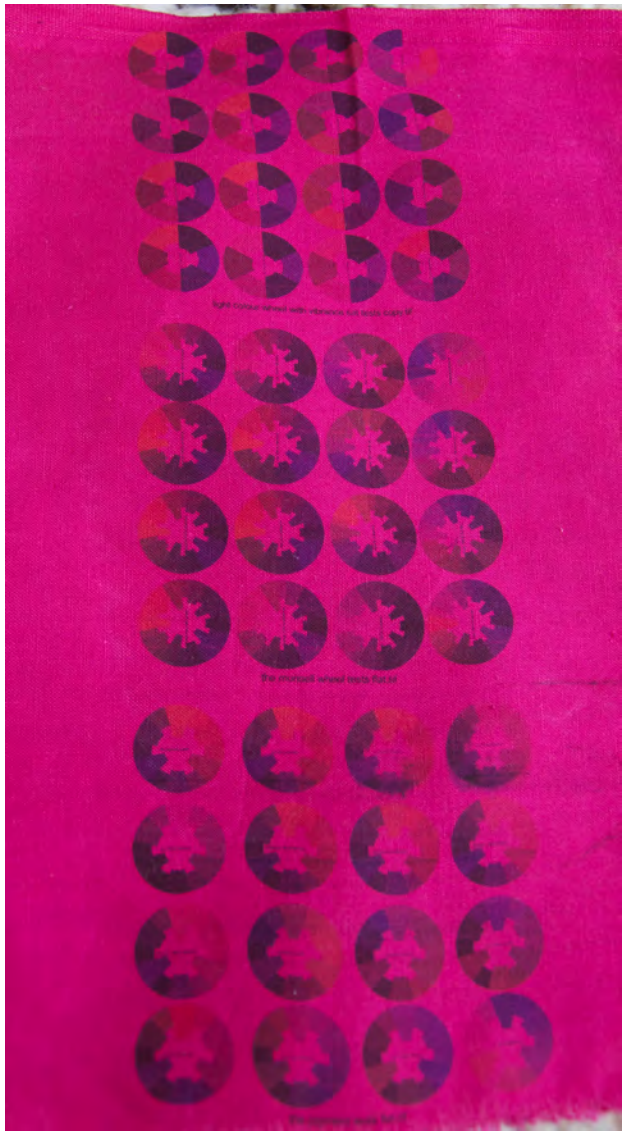
Digitally printing onto colour fabric

- The coated fabric used in digital print is white as part of the preparation for print
- I wanted to look at what happened to printed colour when the colour of the substrate being printed upon was varied
- A series of prints were made using an Epson DX400 which uses Durabrite pigment inks
- The fabrics used were cotton mixes which were cut up to fit the printer and adhesive lables attached to aid the print feed process
- No treatments were made by the researcher to the fabrics. The colours selected were basic rainbow colours bought from a haberdashery shop in Bristol



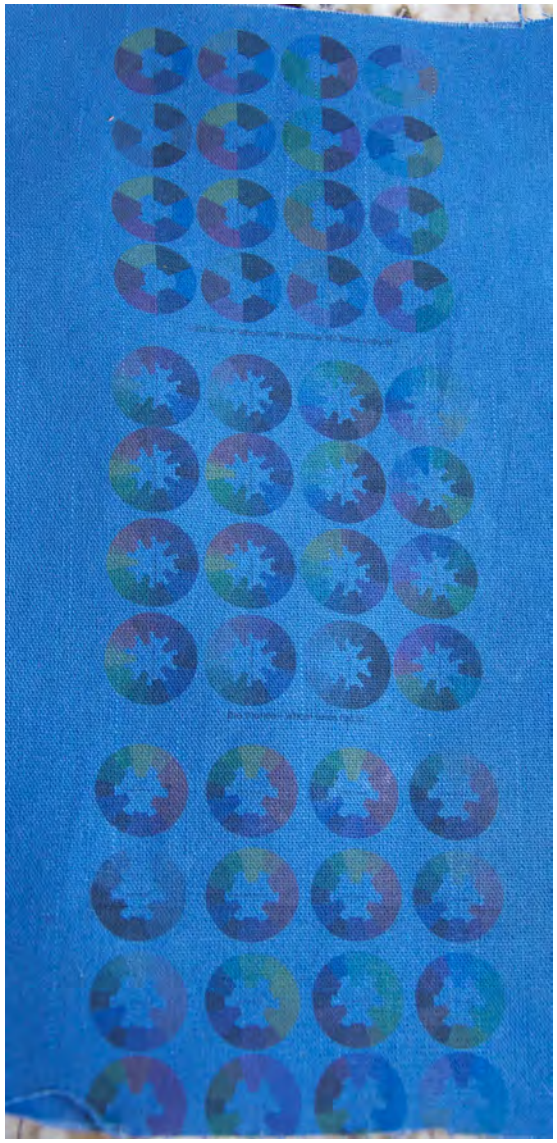
Red

Yellow

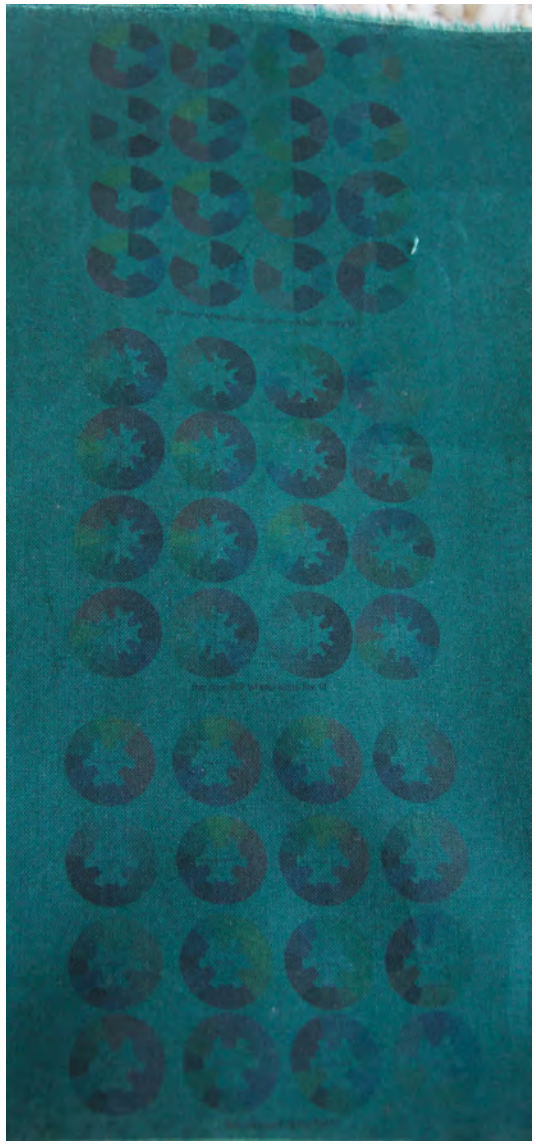


Pink

Light Blue

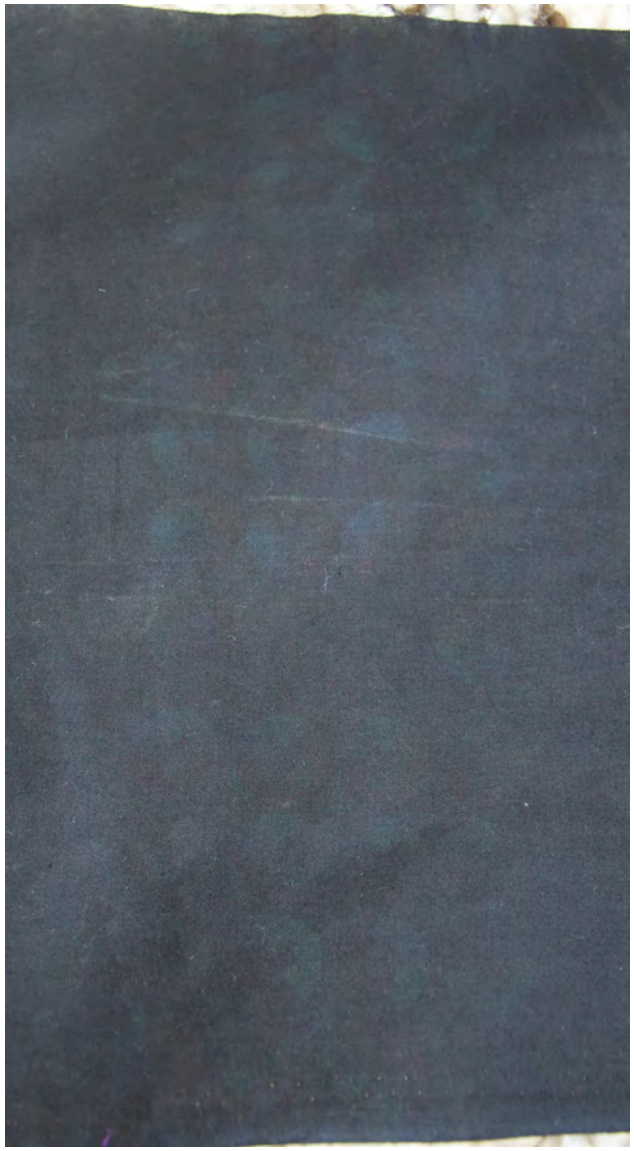


Blue



Green

Purple



Black

Original ArtWork

Observations

- It was really interesting to see what happened to the colours when printing onto coloured fabrics and it was not as I had expected in all cases
- The darker fabrics, purple and black, hardly show the print at all
- The green shows the warmer colours but the darker colours blur and all appear just to be a dark sludge with no definition
- Similarly the red shows only the paler colours (yellow and orange) and all the other colours just appear dark, blur and sludgy
- The pink makes all the darker colours look blue tinged and slightly glowing. Red looks brown, there appears to be a paler space where yellow should be
- Yellow shows the colours clearly. They have a yellow tinge, a 'retro' look to them
- Pale blue shows the colours vividly. The colours appear pleasing to the eye but not as vibrant as the original artwork but offers the clearest colours
- The blue is similar to the pale blue but the colours are a bit harder to see and the darker colours are beginning to blur

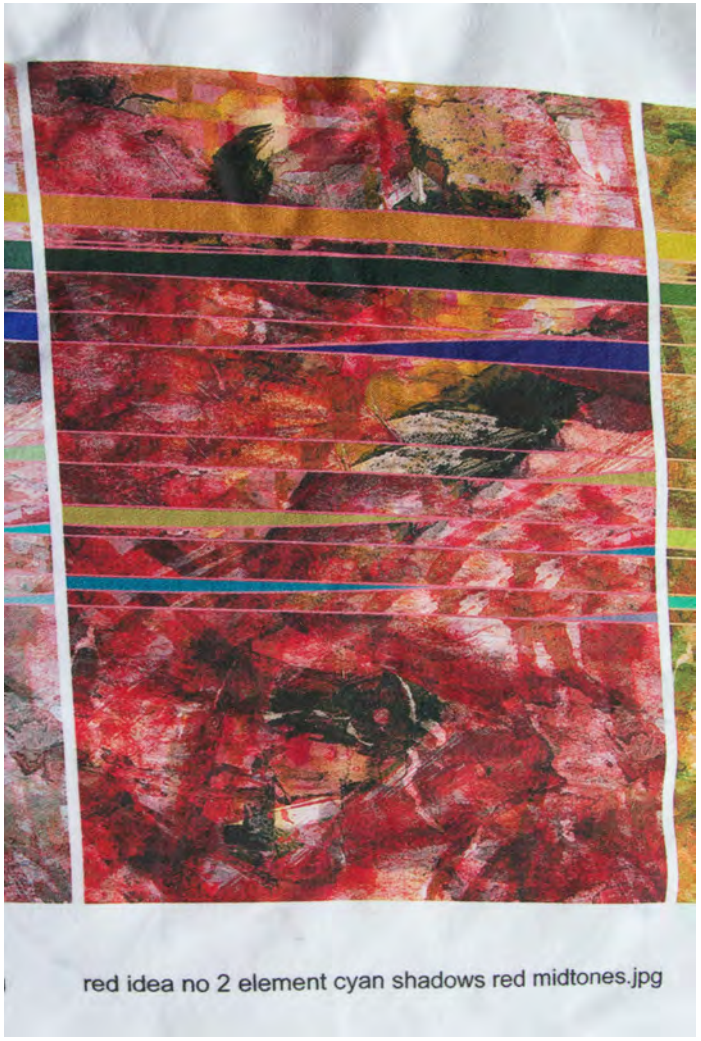
What Next?

- I have spoken to a few companies about getting coloured fabric coated in order to be able to put it through the Mimaki printer but most are hesitant to do so (as they would have to gurantee the fabric meets P2P regulations – RA Smart) or it is costly
- From these experiments however it would be interesting to print on pale blue and yellow fabrics and perhaps pink (to match CMYK?)
- I shall experiment with double printing through the Mimaki by printing a base coat of colour, waiting for the cloth to dry and then printing again ontop of this layer
- I shall also research how to make my own coatings for fabric as suggested by Freya Moses (Falmouth Uni & http://www.freyamomomoses.co.uk/)
- How do these prints relate to theories such as discord colour and coloured greys

Colour Balance – Shadows and Midtones

- The following set of images show experiments made with the colour balance tool in Adobe Photoshop
- The levels were adjusted for each slider so that one slider was set at either +100 or -100 for shadows and midtones.
- The sliders are
  - Cyan – Red
  - Magenta – Green
  - Yellow – Blue
- Further experiments were made where only the midtones were also adjusted.
- These were then printed onto cotton satin and photographed inside in daylight with a Nikon SLR camera

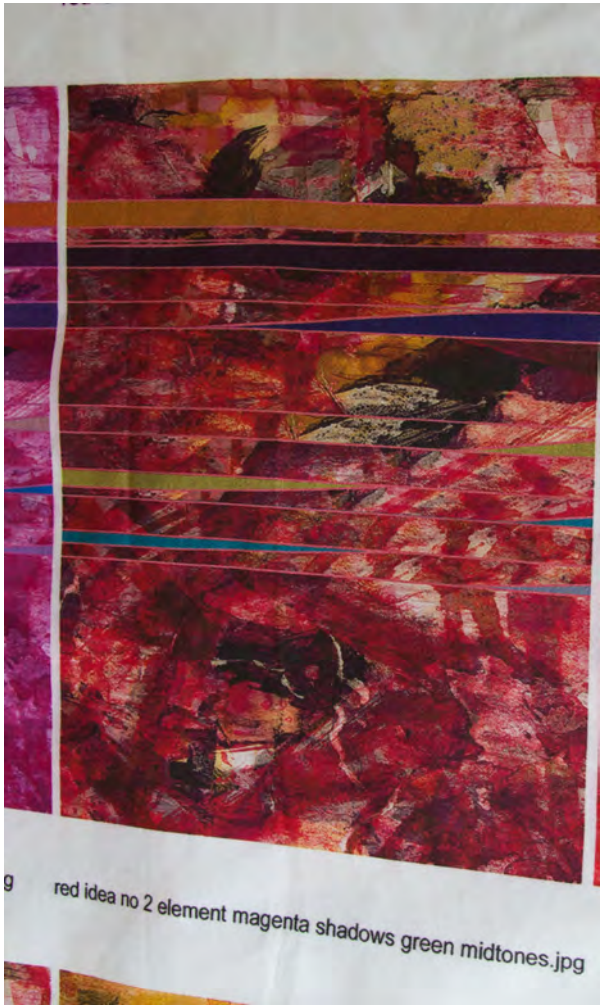
Red Shadows +100, Cyan Midtones -100



Cyan Shadows – 100, Red Midtones +100

Yellow Shadows -100, Blue Midtones +100

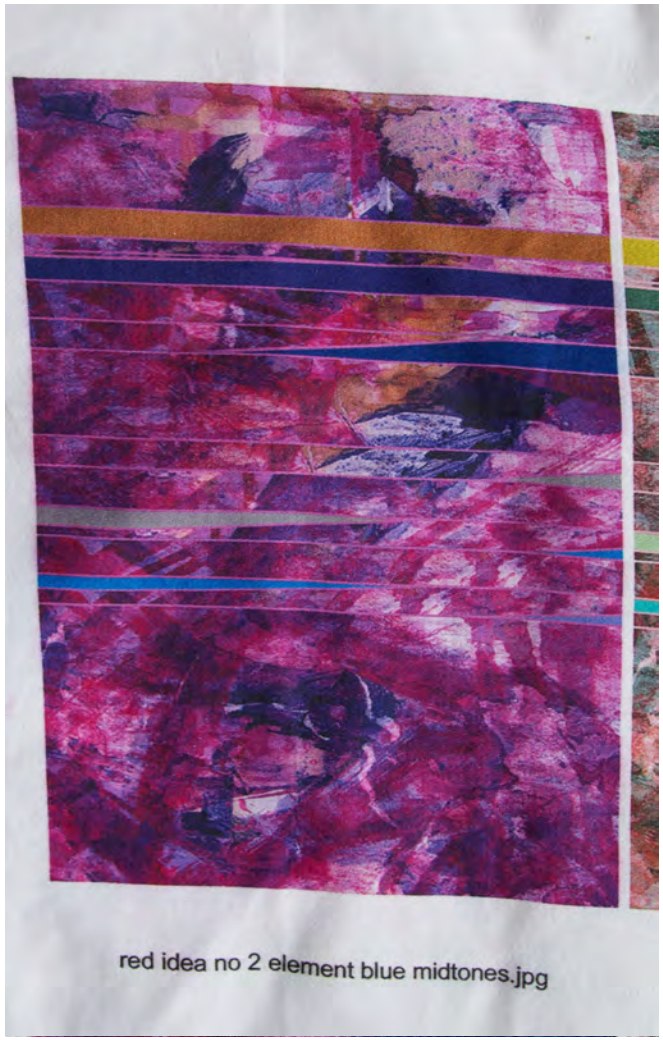
Green Shadows +100, Magenta Midtones -100



Magenta Shadows -100, Green Midtones +100

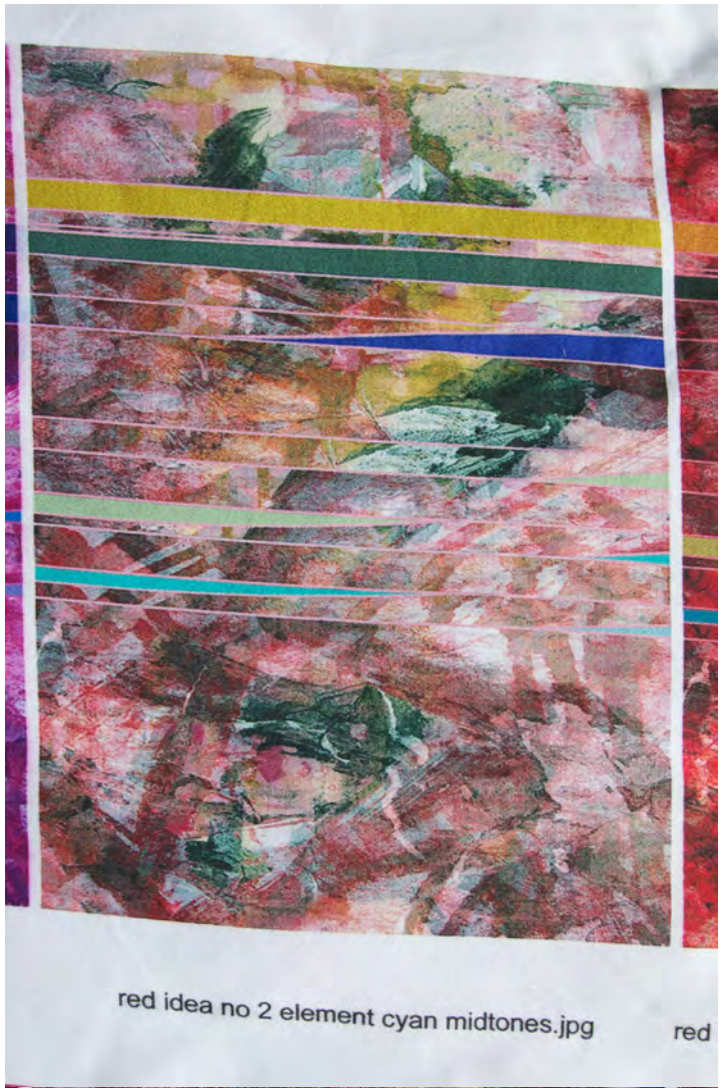
Yellow Shadows -100, Blue Midtones +100

Red Midtones +100



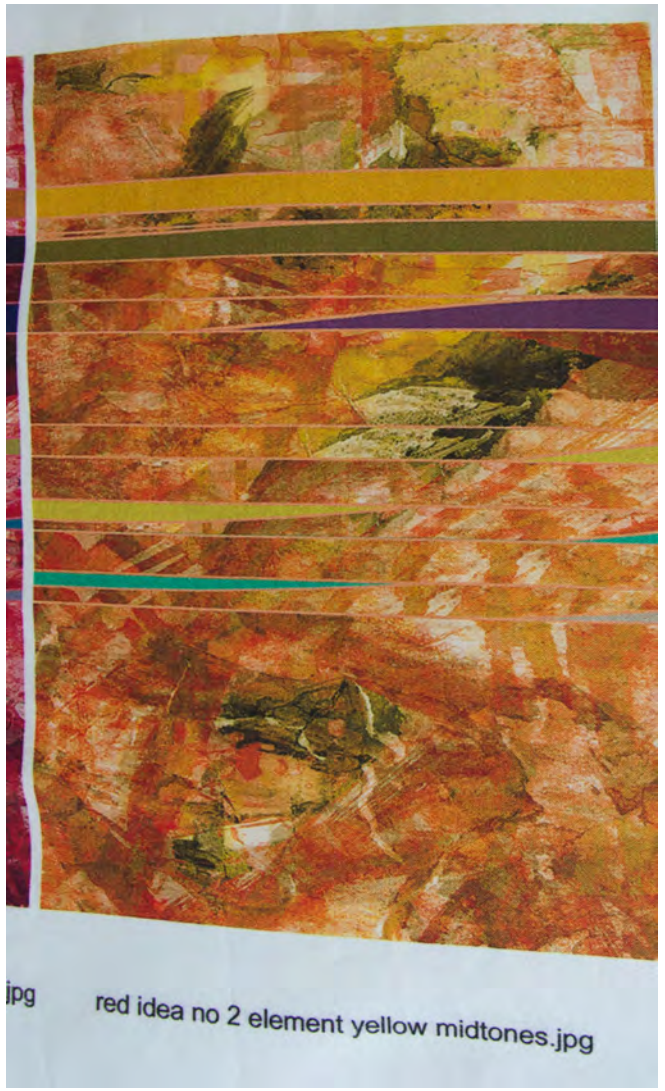
Blue Midtones +100

Green Midtones +100



Cyan Midtones -100

Magenta Midtones -100



Yellow Midtones -100

Overview of all prints

Original ArtWork

Observations

- There were two parts to this experiment for me; seeing how software colour tools could change the colour of a design, and comparing the printed file with the original
- I was interested to see how by bringing together complementary colours the overall hue of the design (red) remained the same. It was only where the midtones were adjusted for one colour that the design changed colour
- When the midtones were changed the colour differences were very similar for blue & magenta, green & yellow but not for red and cyan
- Comparing the prints to the original file there is definitely a lack of definition to tones and lines. But the overall colour matches are not too different

What Next?

- I seem to have been very haphazard with my adjustment choices.
- I would like to repeat the experiment with shadows and highlights
- Annotate the prints to circle and highlight where the differences are
- Find out more about these colour tools, what are they actually doing to the file, how do they change the pixels, how does that relate to the dither pattern / halftone used by the printer

Hue, Saturation, Vibrance & Posterize adjustments

- I have previously experimented with the hue, saturation, vibrance and posterize tools when printing my fabrics to try and get colour matches.
- These experiments have involved small adjustments made to files before sending them to the printers and ‘hoping’ that the colours would come out as I wanted them too.
- I decided to recreate these experiments on a strip print so that I could observe the colour changes directly next to each other
- The files were printed once using the original design’s colours (red tones with white) and then an inverted version (green tones with black) as a comparison of opposite colour combinations

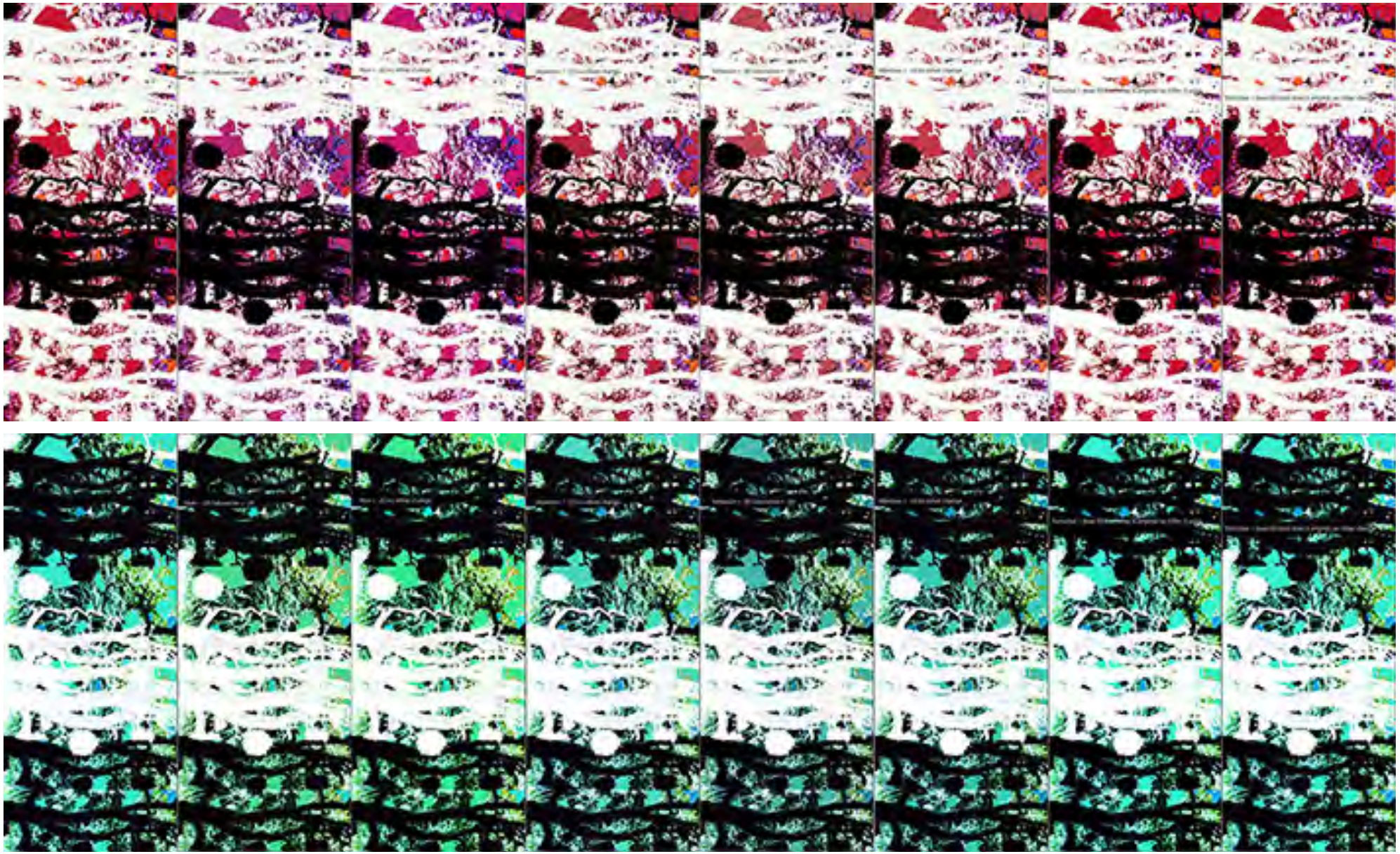
Hue, Saturation, Vibrance & Posterize adjustments

Reading image from Left to Right, each rectangular image has a black outline. File printed twice, once as original colours (red tones with white), second print as inverted colour (green tones with black)

1. Original Art Work
2. Hue –* 20, Saturation – 20
3. Hue – 20
4. Saturation – 20
5. Vibrance – 20, Saturation -20
6. Vibrance – 20
7. Posterize moved to Level 20 from Level 4
8. Posterize moved to Level 60 from Level 4

*- is minus, so each adjustment was a reduction of hue, saturation or vibrance from the original file's settings

Full print 1-8



Observations

- As Hue is reduced the colours become more yellow (red to magenta, green to yellow green)
- As vibrance is reduced the colours become muted
- The saturation reduction is more subtle but the colours are slightly duller but difficult to see unless direct comparison with original
- Changing the posterize levels makes the colours appear brighter and more luminous
- Comparing the print with the original file the colours appear to have more blue in them in the printed designs which you can particularly see in the red series as the hue is reduced

What Next?

- I would like to repeat the experiment but with more extreme adjustments (minus 20 seems very small)
- I would like to repeat the experiment on a variety of fabrics (linen, wool and silk) as I know from past experience that digital print on linen tends to have muted colours whereas silk has very saturated colours so it would be interesting to see how these small adjustments affect this
- As with previous experiments I lack knowledge about how these tools work, I need to find out more about what these colour tools do to the file and how that maps back to the meanings of hue, saturation and vibrance in colour theory

Colour Modes

- Scanned images of skeleton leaves were printed using the different colour modes in Adobe Photoshop
  - RGB
  - CMYK
  - GrayScale
  - MultiChannel
  - LAB Colour
- I wanted to see how the mode changed the image and how the printer would then interpret each image
- The files were printed on cotton satin using a Mimaki printer and then photographed inside in daylight using a Nikon SLR camera

LAB Colour

Multi Channel Colour

CMYK Colour

Grey Scale Colour

Where is the RGB?

For some reason I failed to print the RGB file!
But here is the original scan

Observations

- The printer was not able to understand (or the AVA software) the multichannel mode
- CMYK was very yellow in tone
- LAB colour very blue
- Greyscale also difficult for AVA software (or printer) to interpret
- In comparing the CMYK and the LAB colour the CMYK appears clearer, especially in the detail of line

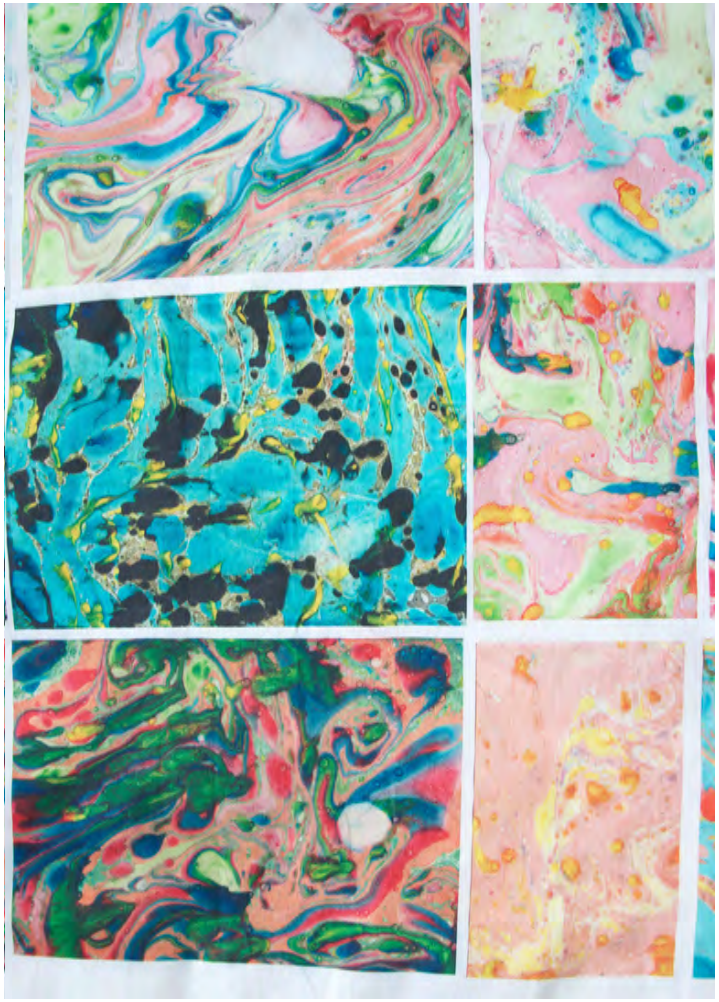
What Next?

- I am not sure I want to repeat this experiment or go ahead and print the RGB file, however it was useful to know that the software / printer couldn't interpret the grey scale and multichannel modes.
- I shall experiment with other designs by printing in CMYK, LAB and RGB modes and make comparisons with these
- The lack of detail in the LAB file, especially in picking out the finer lines is also interesting but I am not sure if that is related to colour
- I again lack the knowledge about these modes. CMYK, LAB and RGB seem fairly self explanatory but I need to look and compare the gamuts that they have to see overlaps, out of gamut colours etc
- What is multichannel colour mode? Find out !

Marble Designs

- I wanted to create a series of fabrics which utilised tonal colour variations, mimiced artist techniques and used scanned imagery
- I made a series of marbled papers using basic marble inks (red, black, blue, green, yellow & orange)
- These were then scanned in using a Brother MFC A3 Scanner Printer and printed onto cotton satin using a Mimaki printer
- The prints were then photographed inside in daylight using a Nikon SLR camera
- Additionally one image was adjusted in Adobe Photoshop using the Halftone filter where pixel size and colour channels can be adjusted

m20 pixel 10 channels 100.jpg
m20 pixel 20 channels 200.jpg
m20 pixel 5 channels 50.jpg



Three halftone adjustments were made
Left to Right

1. Pixel size changed to 5, Channels all set to 50
2. Pixel size changed to 20, Channels all set to 200
3. Pixel size changed to 10, Channels all set to 100

Original CAD files

Observations

- In comparing the colours between the prints and the CAD files there are subtle differences in tone and quality of print
- The colours in the print all appear darker than the CAD file
- I did not make comparisons between the scanned images and the original marbled papers as I felt that would be too confusing but perhaps I should
- The yellows and greens in the marbled prints seem to be more dominant than in the CAD files where the warmer colours and the blues stand out. The warmer colours lack tonal distinction in the prints and the blues are darker.
- The halftone filter experiment is a bit haphazard. I was trying to understand how the tool worked and continued the experiment with another design. The definition of the image, rather than the colour, seems to have been affected

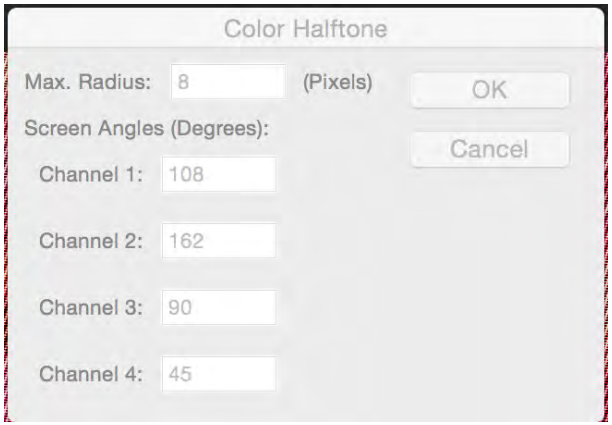
What Next?

- I am a bit of a loss as to what I have learnt from this experiment so I need to revisit the prints and annotate them to really highlight the differences in colour and tone definition
- The halftone filter doesn't seem to have changed the colour much, rather the image has become pixalated
- I therefore need to find out more about the halftone tool to see if it can be used to change colour or whether creating a brush tool that mimics a printers dithering pattern (or halftone pattern) would have greater colour affects

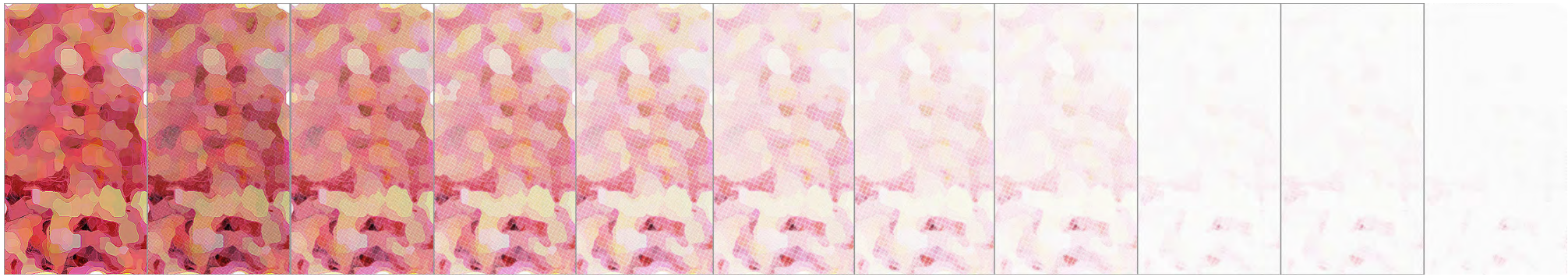
Half Tone patterns

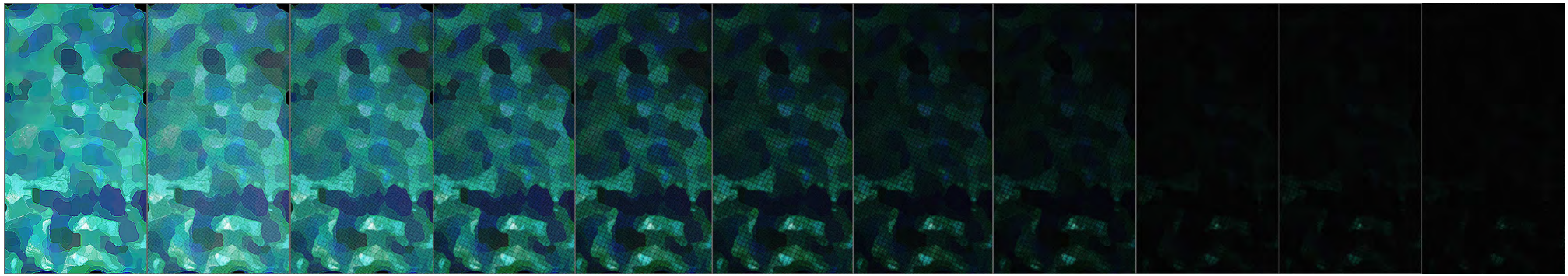
- In beginning my research I have been reading about how printers make up colour and came across the idea of halftone which I began to experiment with in the marble prints
- Half Tone uses dots of colour (from the printer inks CMYK and in more complicated printers such as the Mimaki Light versions of cyan and magenta are introduced along with red, or orange and purple are added). The dots are built up in patterns to give the appearance of ta third colour. As well as halftone there is dithering which uses a similar pattern dot technique to build up colour
- Using the Adobe Photoshop Halftone Filter I adjusted a digital design to change the half tone pattern. The tool allows you to change the radius size of the pixels and the channels. There are 4 channels and they are measured in degrees
- From left to right the colour halftone filter was repeatedly applied using the default settings in Adobe Photoshop Creative Cloud
- This filter can be found in the pixelate menu of Filters

The images were then placed next to each other to create a sliding scale and collaged together
The final collage was inverted as a colour comparison
Red was chosen as the overall dominant colour because warmer tones can be tricker to print
The inverted print is green and black



The files were printed onto cotton satin using a Mimaki printer
and the prints photographed using a Nikon SLR camera inside in daylight





Observations

- As the halftone filter is applied the colours become muted and eventually become bleached out (in the red white image) or completely black (in the green black image)
- The greatest affect is the loss of definition of the overall image as it becomes more pixelated

What Next?

- Like with a lot of my Adobe Photoshop experiments my lack of understanding of the tool and how the software works has hindered my understanding of the results. I therefore need to find out more about the halftone tool and make more experiments before I can find out if it actually aids colour reproduction or not. I suspect that it doesn't…

Colour Wheels

- As part of the module Research Portfolio, I reviewed the history of colour theory, putting together a chart of colour theorists and making a collection of colour diagrams to try to identify which theorists might be most useful to my research for further reading
- Additionally I explored three colour wheels; pigment, light and munsell.
  - Pigment Wheel – the artists' colour wheel, using red, yellow and blue primaries
  - Light Wheel – the physicists' colour wheel, using red, green and blue primaries
  - Munsell Wheel – Albert Munsell's colour wheel which placed complementary colours opposite each other, 'simultaneous contrast'
- These colour wheels were recreated in Adobe Photoshop. I experimented with each wheel by making adjustments to saturation and vibrance in the Vibrance tool and to hue in the Hue/Saturation tool. These experiments were placed in a grid formation and each 'square' of colour printed onto cotton satin
- The files were printed onto cotton satin using a Mimaki printer and were photographed inside in daylight using a Nikon SLR camera

From Left to Right

Row One

1. The Pigment Wheel
2. Saturation + 50 in Vibrance tool
3. Saturation +100 in Vibrance tool
4. Saturation -50 in Vibrance tool

Row Two

1. Saturation – 100 in Vibrance tool
2. Vibrance + 100 in Vibrance tool
3. Vibrance + 50 in Vibrance tool
4. Vibrance – 50 in Vibrance tool

Row Three

1. Vibrance – 100 in Vibrance tool
2. Hue + 50 in Hue / Sat
3. Hue +100 in Hue / Sat
4. Hue + 150 in Hue / Sat

Row Four

1. Hue – 50 in Hue / Sat
2. Hue – 100 in Hue / Sat
3. Hue – 150 in Hue / Sat
4. The Pigment Wheel Inverted

From Left to Right

Row One

1. The Light Wheel
2. Vibrance + 50 in Vibrance tool
3. Saturation – 100 in Vibrance tool
4. Vibrance + 100 in Vibrance tool

Row Two

1. Saturation -50 in Vibrance tool
2. Saturation + 50 in Vibrance tool
3. Saturation +100 in Vibrance tool
4. Vibrance – 50 in Vibrance tool

Row Three

1. Vibrance – 100 in Vibrance tool
2. Hue + 50 in Hue / Sat
3. Hue +100 in Hue / Sat
4. Hue + 150 in Hue / Sat

Row Four

1. Hue – 50 in Hue / Sat
2. Hue – 100 in Hue / Sat
3. Hue – 150 in Hue / Sat
4. The Light Wheel Inverted

From Left to Right

Row One

1. The Munsell Wheel
2. Vibrance + 50 in Vibrance tool
3. Vibrance + 100 in Vibrance tool
4. Vibrance – 50 in Vibrance tool

Row Two

1. Vibrance – 100 in Vibrance tool
2. Saturation + 50 in Vibrance tool
3. Saturation +100 in Vibrance tool
4. Saturation -50 in Vibrance tool

Row Three

1. Saturation – 100 in Vibrance tool
2. Hue + 50 in Hue / Sat
3. Hue +100 in Hue / Sat
4. Hue + 150 in Hue / Sat

Row Four

1. Hue – 50 in Hue / Sat
2. Hue – 100 in Hue / Sat
3. Hue – 150 in Hue / Sat
4. The Pigment Wheel Inverted

The Pigment Wheel – Original ArtWork

The Light Wheel – Original ArtWork

The Munsell Colour Wheel – Original ArtWork

Observations

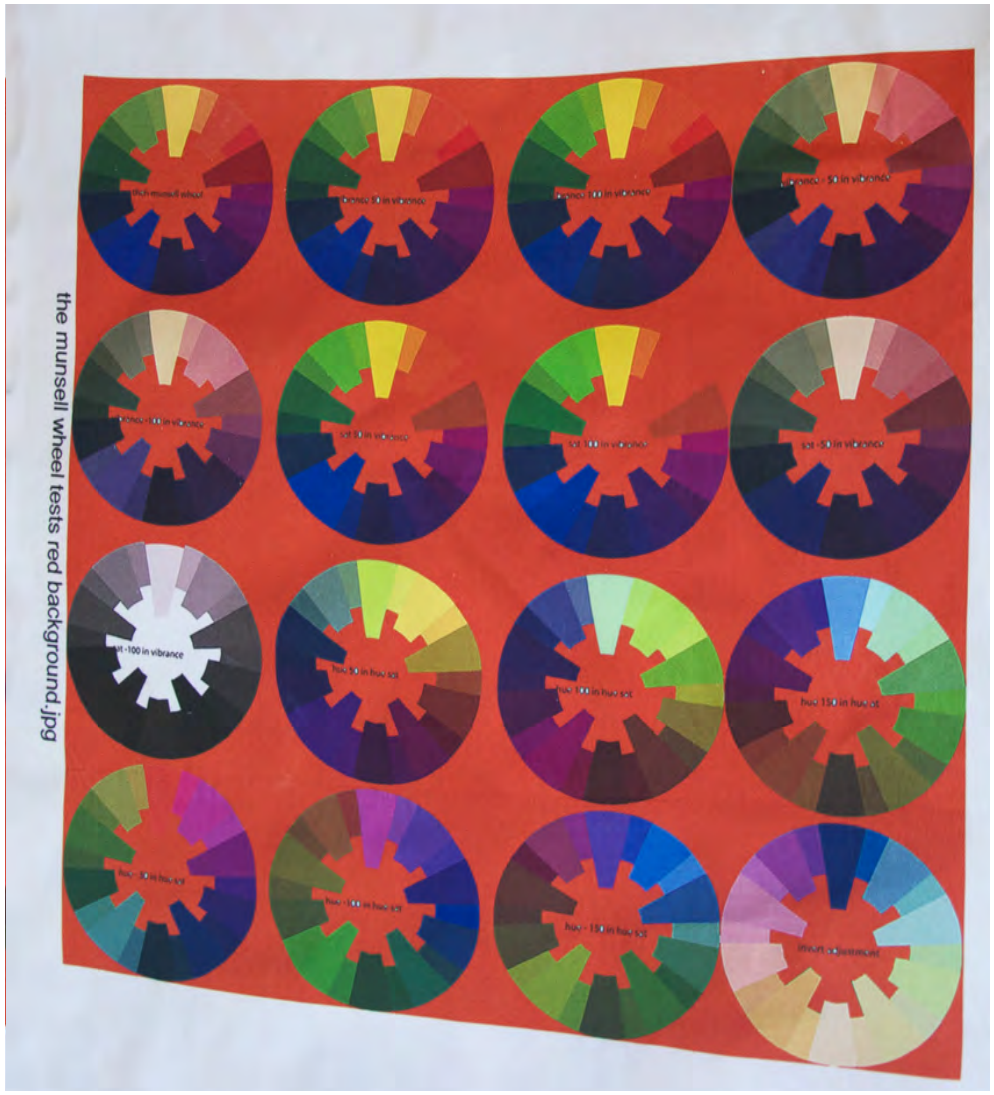
- These prints for me gave the clearest indication of the colour differences between the monitor and the printer. It is easy to directly compare blocks of colour rather than tones
- The original artworks are much brighter and more saturated in particular in the warmer colour ranges
- The second part of the experiment, looking at colour tools in photoshop, also yields easier to compare results because I can compare the blocks of colour not only with the original files but also with the initial wheel at the start of each colour square
- Increasing vibrance in the prints did increase the brightness of the printed colour and reduced it where the vibrance was reduced although the increase is more subtle in the print than the CAD file
- Saturation and vibrance colour tools seem to do fairly similar things to colours
- Hue changes, as expected, give a different tone of colour, some of which are quite neon and acidic looking which is exciting
- Inverting the colour wheels provides a pastel version of the colour wheel
- Reduced saturation provides a grey version of the colour wheel

What Next?

- I'd like to go back into the files and look at the colour data behind these colours
- For example what is the hex colour of each block of colour (the 6 digit number used in web colours)
- What is the LAB breakdown and RGB breakdown of these colours
- I shall then create a chart of this data to use for future colour choices

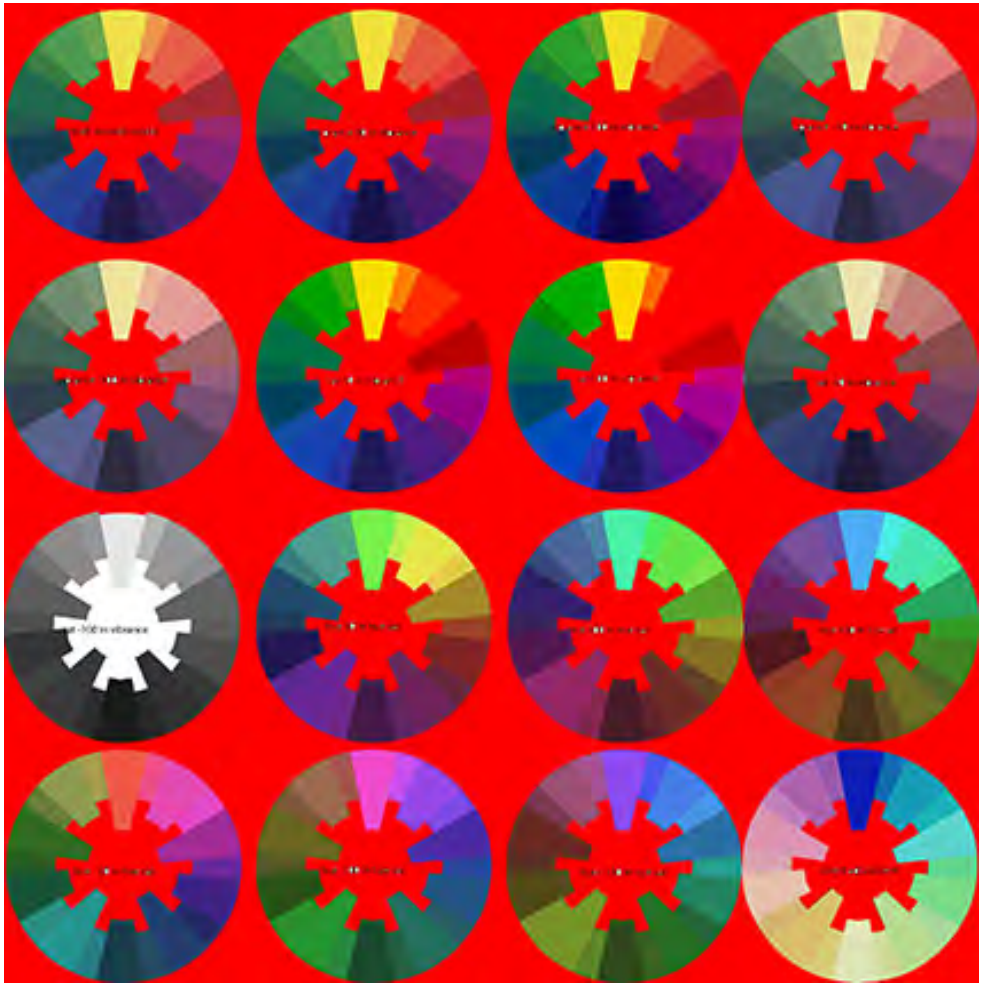
The Munsell Wheel printed on coloured backgrounds

- The Munsell Wheel offers an insight into ‘simultaneous contrast’ where a colour can appear visually different when placed next to another colour.
- I printed the Munsell Colour Wheel square previously created on to 6 different coloured backgrounds using the red, green, orange, blue, purple and yellow from the original Munsell Wheel.
- The prints were made on cotton satin using the Mimaki printer and photographed inside in daylight using a Nikon SLR camera

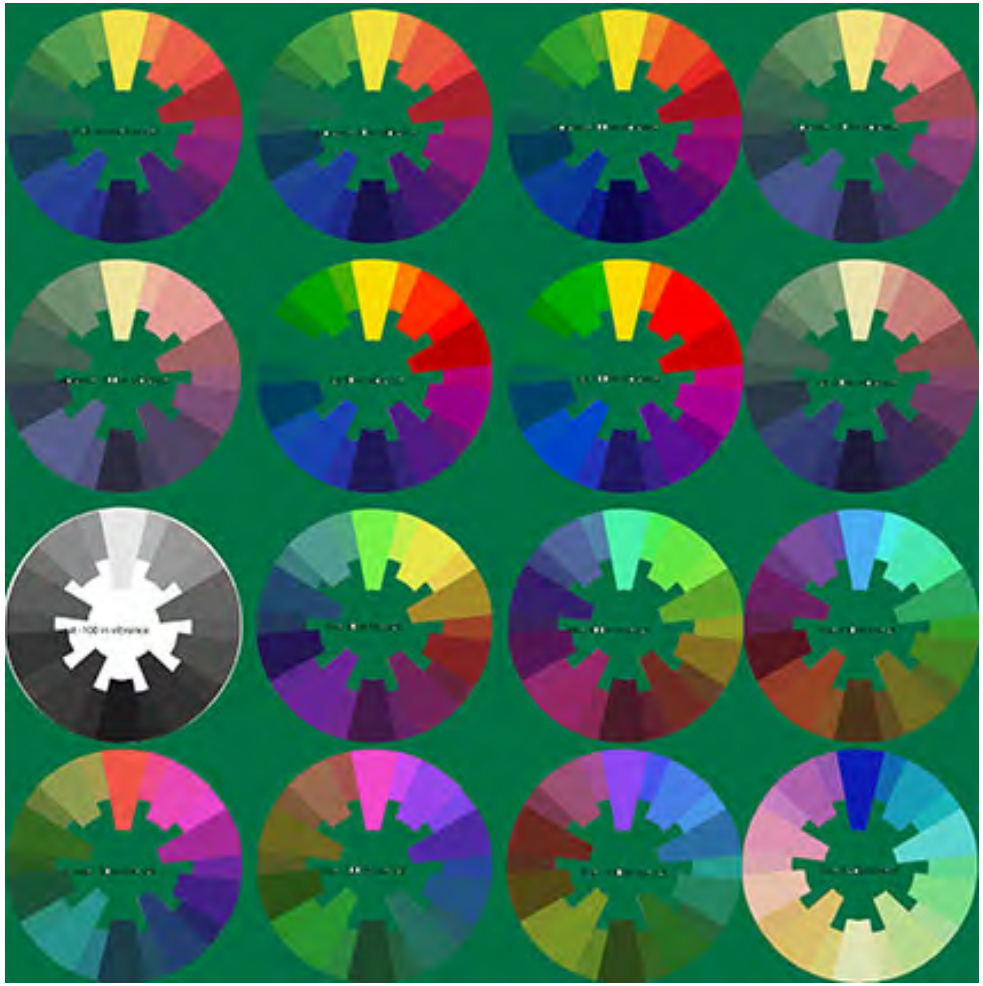


The Munsell Wheel printed on a red background

The Munsell Wheel printed on a green background



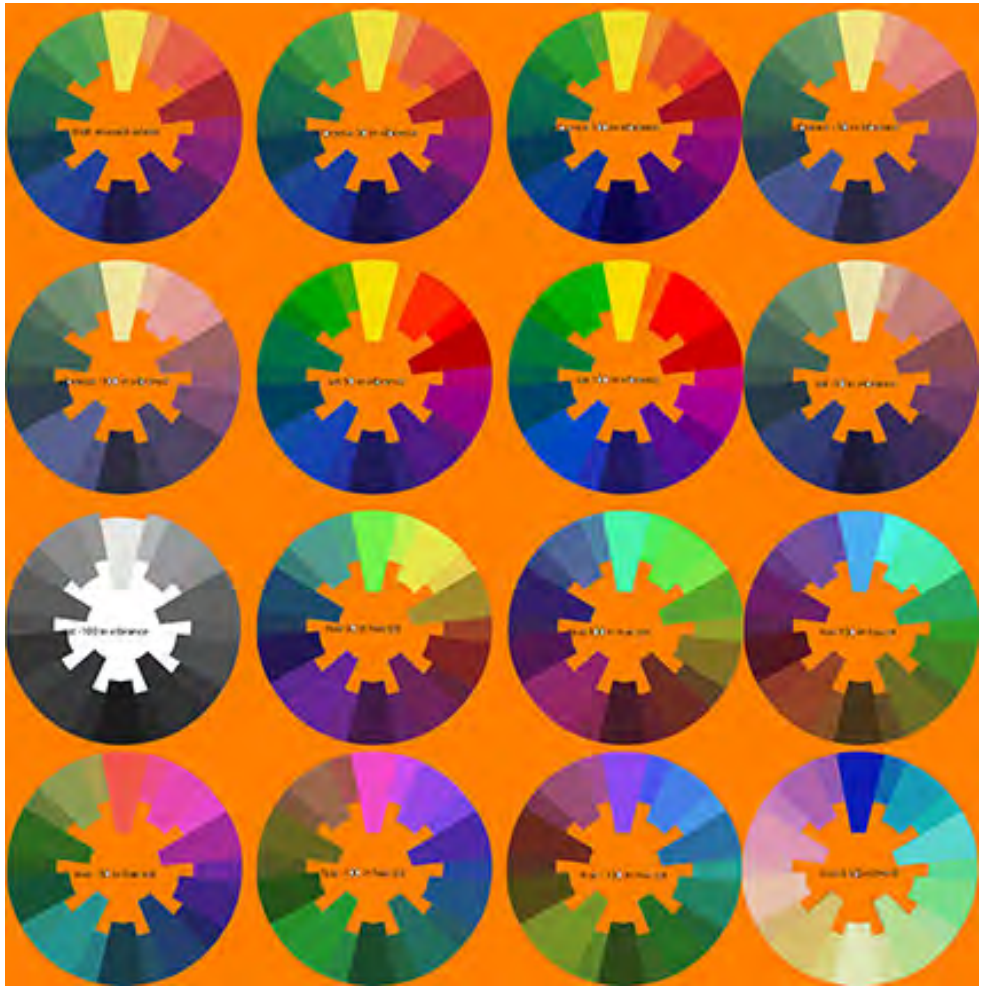
Munsell on red – Original ArtWork



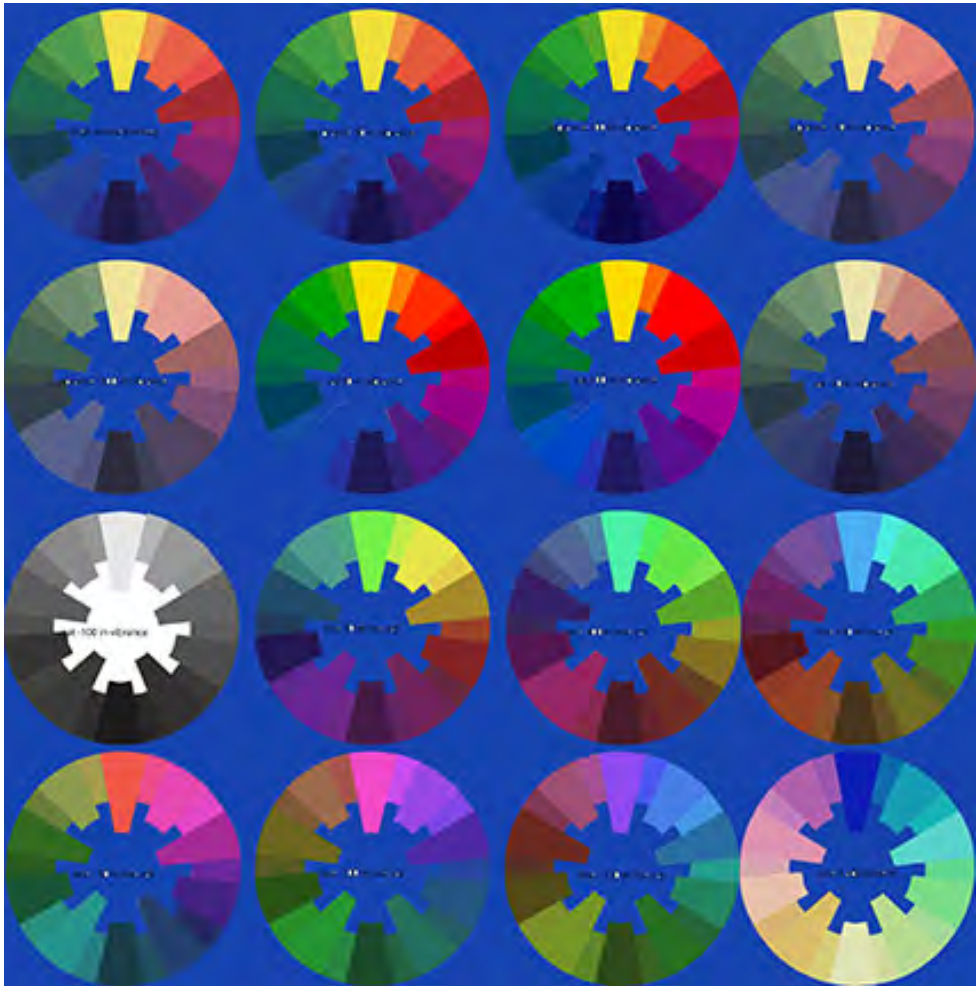
Munsell on green – Original ArtWork

The Munsell Wheel printed on an orange background

The Munsell Wheel printed on a blue background



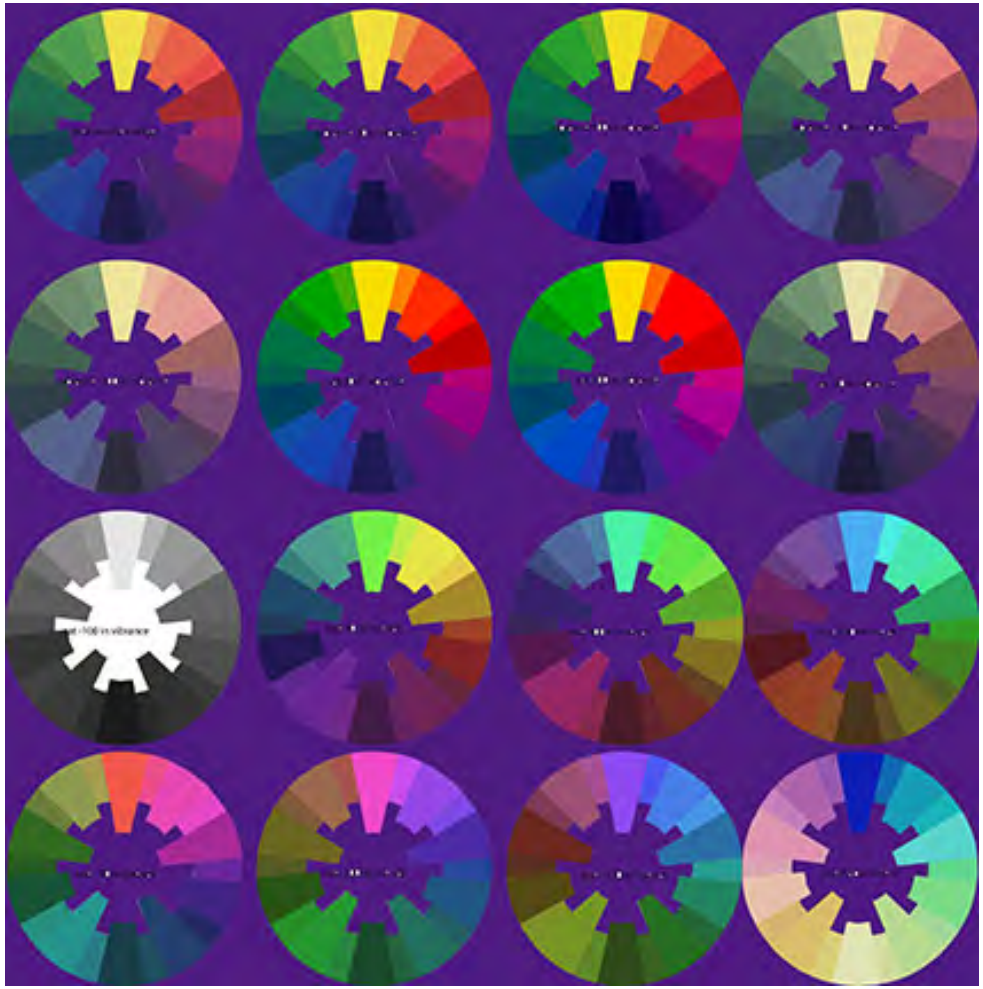
Munsell on orange – Original ArtWork



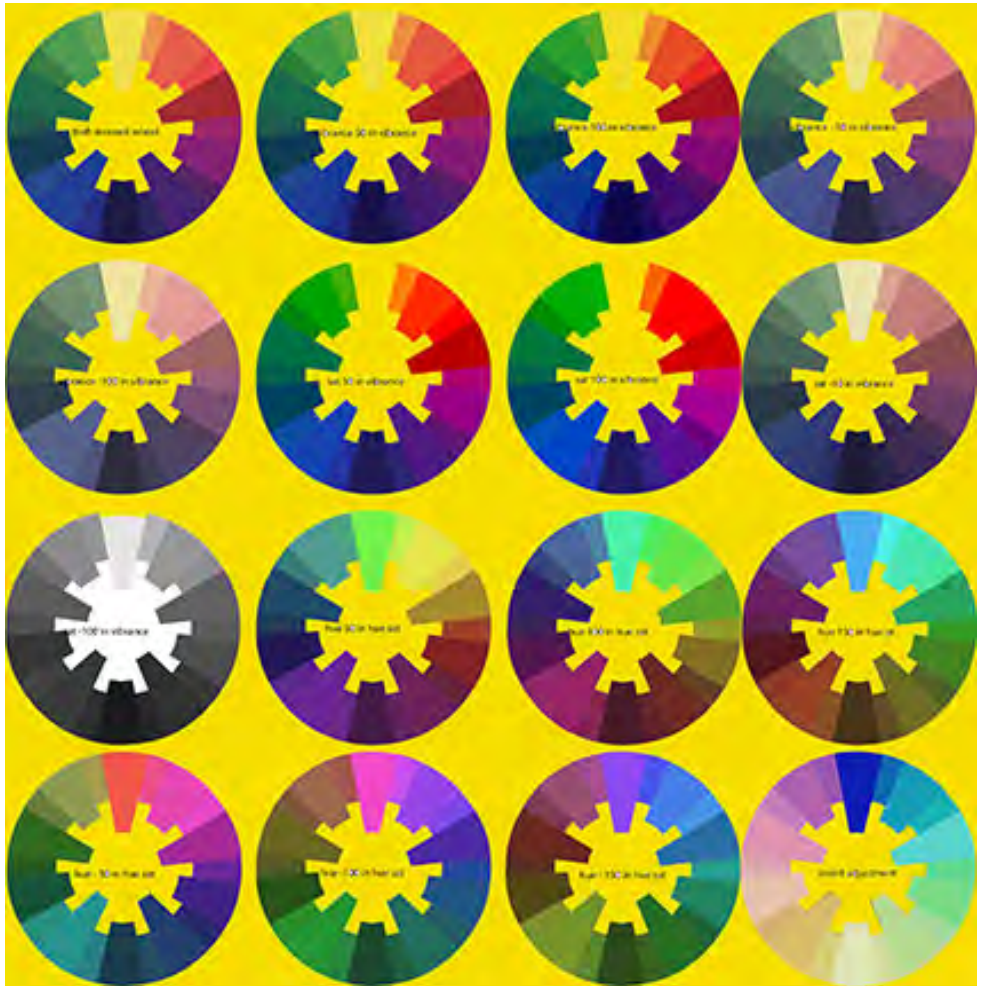
Munsell on blue – Original ArtWork

The Munsell Wheel printed on a purple background

The Munsell Wheel printed on a yellow background



Munsell on purple – Original ArtWork



Munsell on yellow – Original ArtWork

Observations

- The colour differences between the CAD files and the prints are again much clearer and easier to compare blocks of colour
- The CAD files are brighter and more saturated
- The prints appear muted in colour and desaturated in comparison
- The yellow in particular seems sludgy. The red much more orange than its CAD original. The best colour matches are the darker colours (green, blue and purple)

What Next?

- I need to make a more detailed comparison of how the colours change next to these coloured backgrounds
- I would like to make a comparison by printing these as a double print, the background printed first and then the fabric put back through to print the colour wheels as I feel that this test hasn't been 'proper' because the colours are separate, but perhaps that's not the point of simultaneous contrast

Complementary Colours

- Progressing the colour wheel work with complementary colours and simultaneous contrast I created a fabric design in green and red tones as these are opposite colours on the colour wheel and should when placed next to each other make the other one appear more vibrant
- I then took this design into Adobe Photoshop and adjusted the colour mixes to utilise the other complementary colour pairs of orange and blue and yellow and purple / magenta
- Additionally I inverted the original colour way in Adobe Photoshop to create a 4th colour way
- These designs were then printed on cotton satin using a Mimaki printer and photographed inside in daylight using a Nikon SLR camera

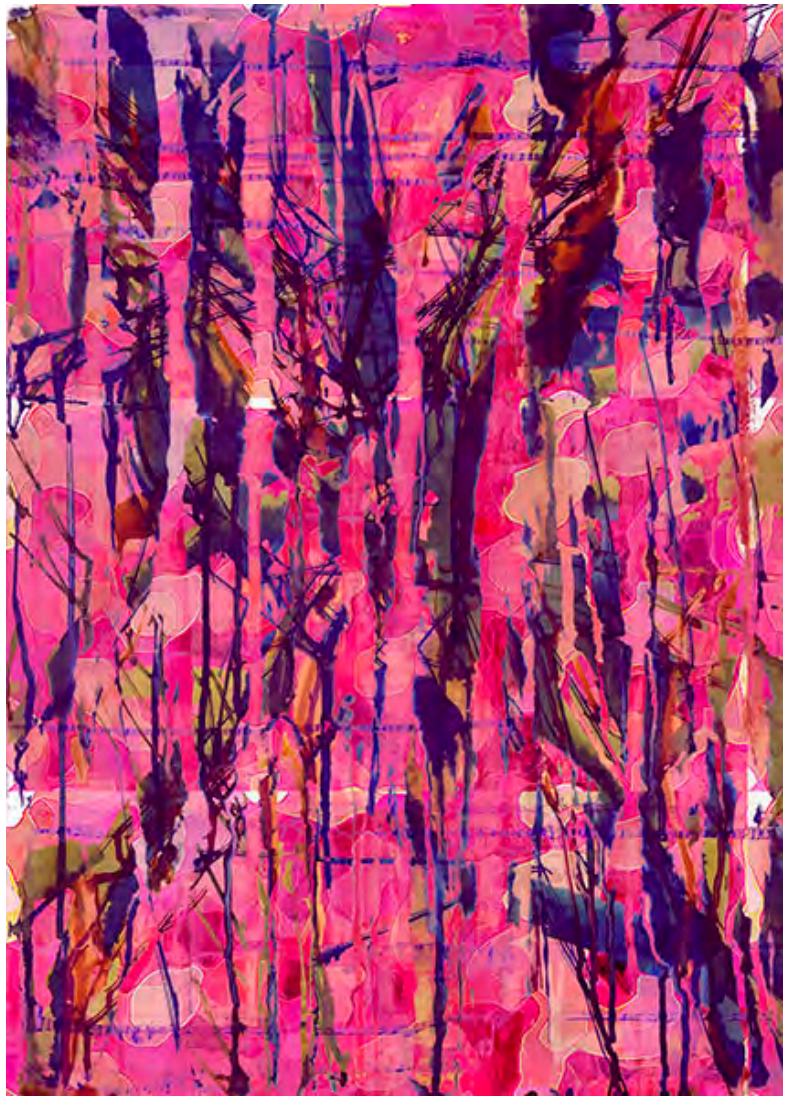
Red & Green Colourway One

Original ArtWork

Orange & Blue Colourway Two

Original ArtWork

Magenta & Yellow Colourway Three

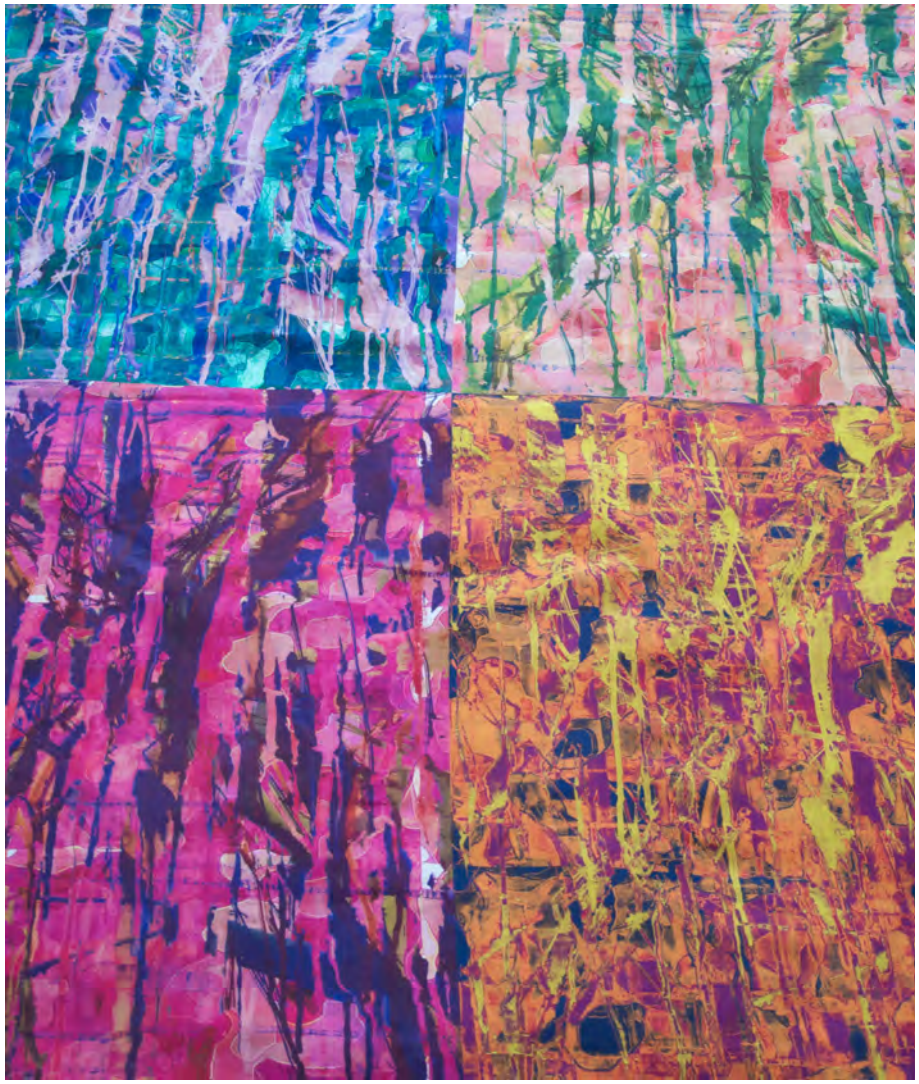


Original ArtWork

Red & Green Colourway Inverted

Original ArtWork

Original ArtWork



All Four Prints

Observations

- The differences between the print and the CAD file are again clear to see
- Colours are less saturated and more muted in the prints
- The closest colour match is between the inverted file which is darker and has a range of blues and greens in it
- The red green print is bluer than the original file
- The orange blue print is warmer in tone, less acidic and luminous
- The magenta yellow print is a good colour match but the blues are muted

What Next?

- These adjustments were made in a haphazard way by using the magic wand tool to select areas and then change their colour using the pantone colour libraries and hex colour charts so the colour changes do not map against a particular colour wheel
- In terms of looking at simultaneous contrast and complementary colours I need to make further observations by annotating the prints directly
- It is interesting that the colour match was least accurate in the orange blue print which is predominantly orange. I have been experimenting with red images but perhaps I need to incorporate more orange to test out this colour range with the printer

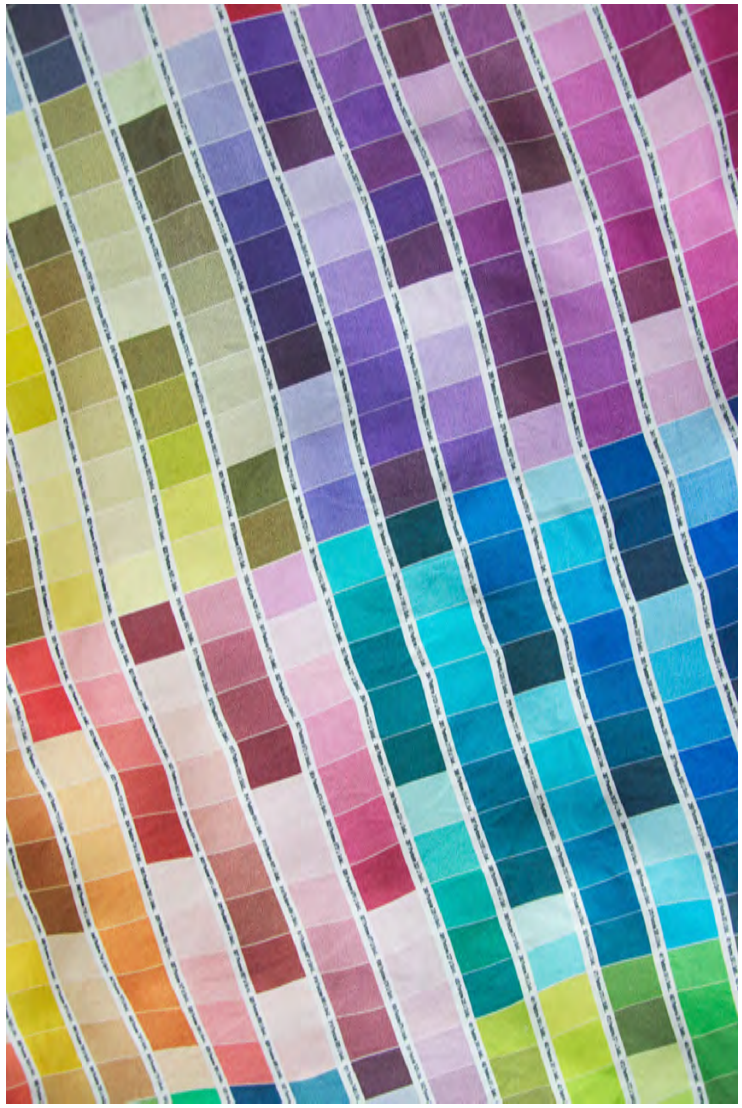
Pantone colour library

- At UWE, Textiles Students are taught to use the Pantone Colour libraries as their colour reference.
- Adobe Photoshop Creative Cloud provides several Pantone Colour libraries including Pantone Solid Uncoated which would be the most appropriate colour library to use
- I created a square of ‘solid’ colour for each of the 1137 colours in the Pantone Solid Uncoated colour library which in turn were turned into 12 contact sheets
- These were then printed on linen, wool, cotton and silk as a comparison of how different cloths take digital colour. The printer was the Mimaki printer and then the prints were photographed inside in daylight with a Nikon SLR camera

Linen

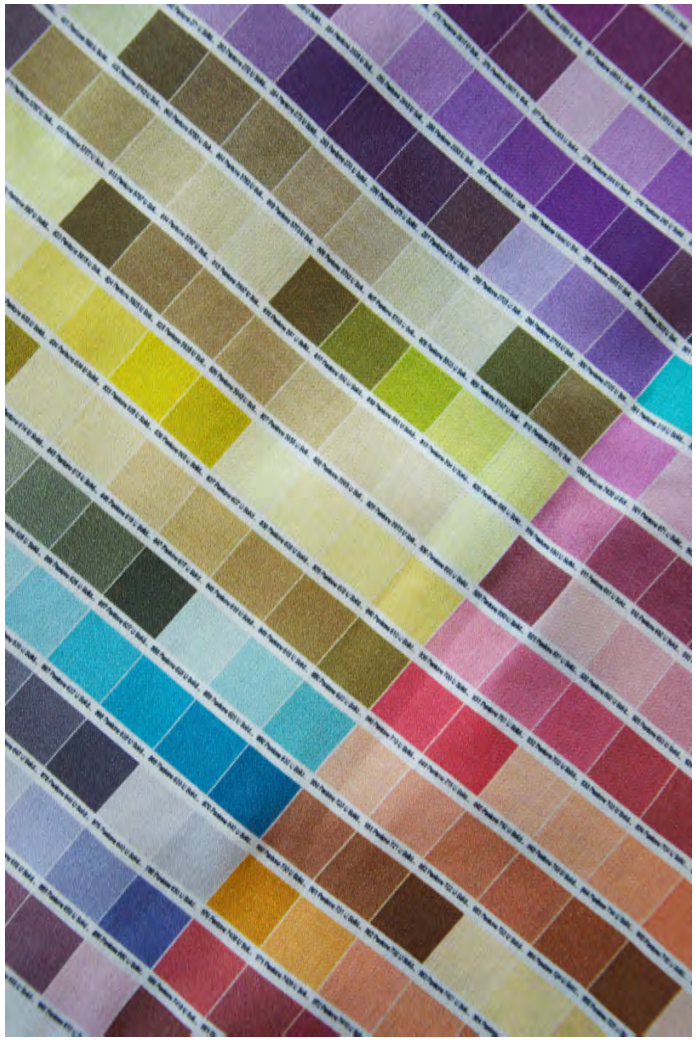
Linen Detail

Silk



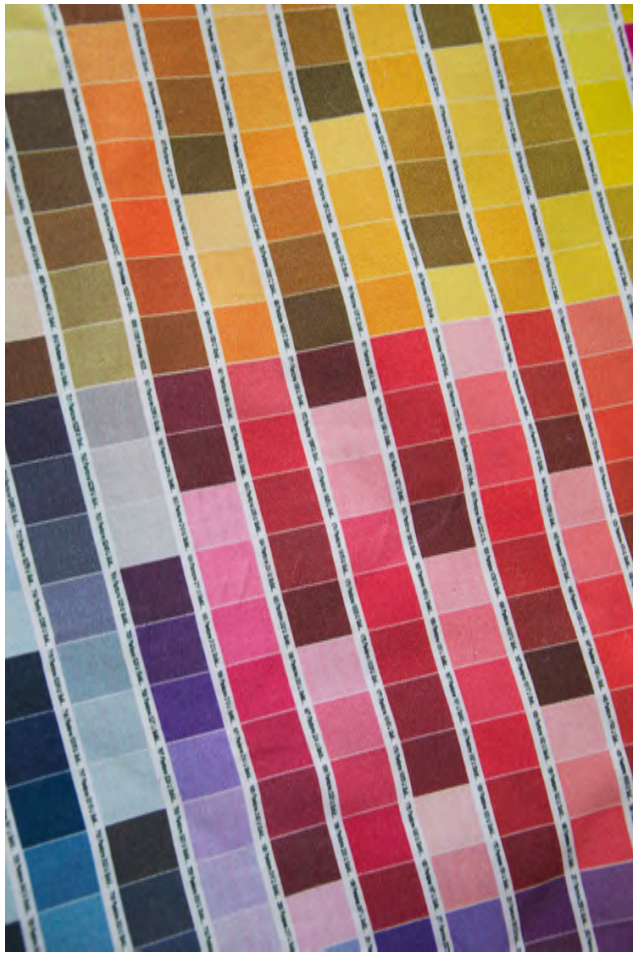
Silk Detail

Wool

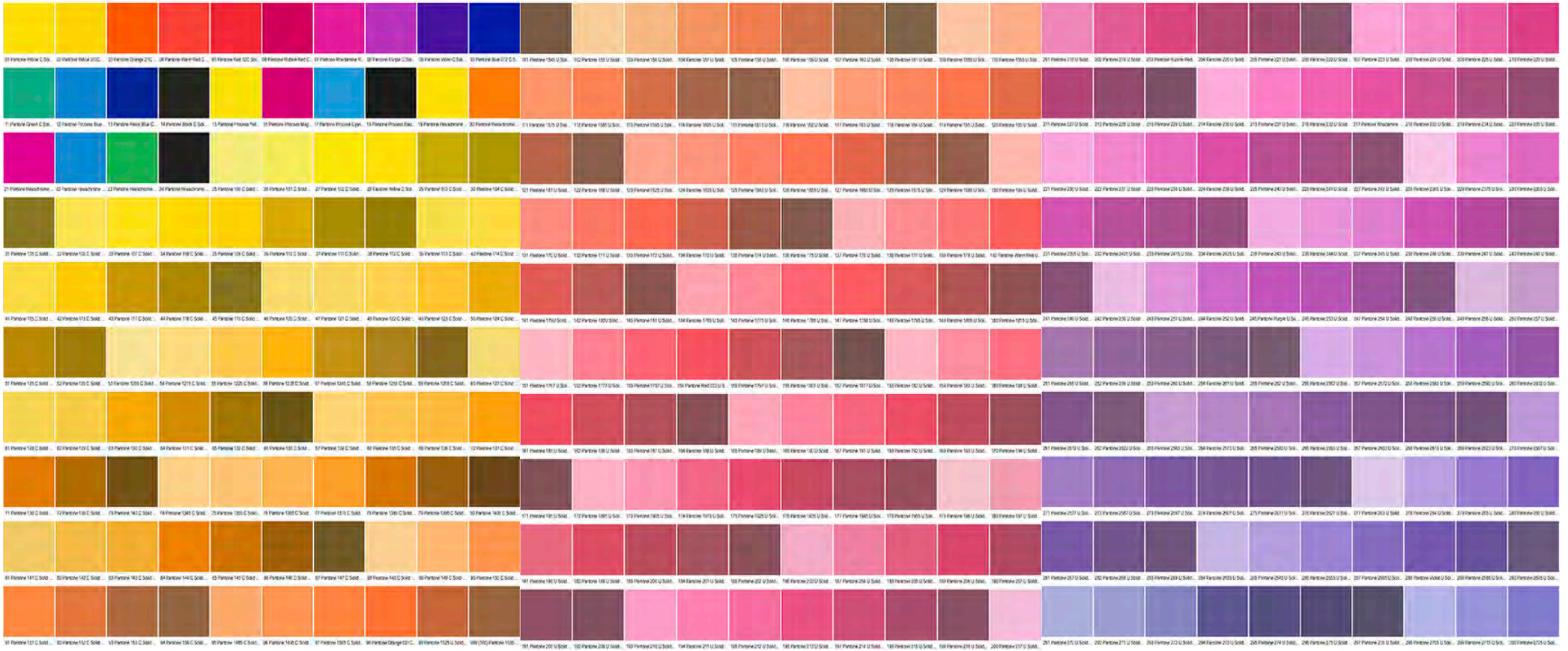


Wool Detail

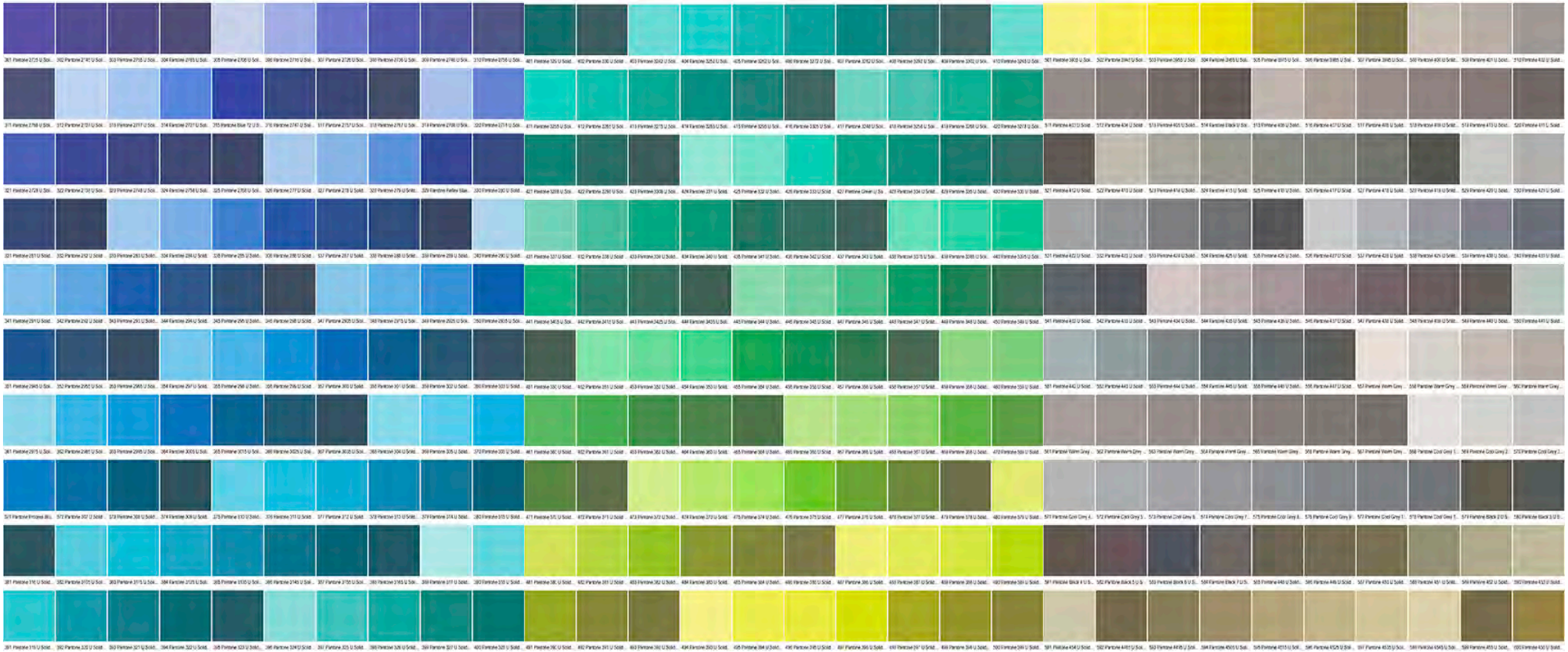
Cotton



Cotton Detail



Pantone Colour Charts 1-3 of 12



Pantone Colour Charts 4-6 of 12

Pantone Colour Charts 7-9 of 12

Pantone Colour Charts 10-12 of 12

Observations

- I really enjoyed creating these colour charts. It has been really exciting to see all 1137 colours printed out and I feel that I can use these as the basis for future design works and experiments
- The extreme variations that I've found when printing on different fabrics are not as apparent when printing on fabrics directly from a computer that is calibrated for the printer but there are subtle differences between the four fabrics. The wool and linen are more muted, the silk is the most saturated and the cotton next.
- I much prefer using linen and wool to print on than cotton, the way these fabrics take colour and the texture they have is much more aesthetically pleasing
- The colours on the silk seem too acidic aesthetically

What Next?

- I need to photograph the exact same detail from each cloth and place them side by side for full comparison
- I need to annotate the prints to show these comparisons
- The neon ranges and metallics have been proven to be hard to replicate through print so now I have identified these colours then I should do further designs to test these out
- I would like to drill down into the colour data and look at the LAB colour and RGB colour data behind each colour and put this in a table to map against the visuals

Becky Gooby

Research Practice

Year Two and Three

The development of methodologies for digital colour printing in textile design, through an understanding of interwar historical colour palettes

Pre-Coatings

- Research was conducted into pre-coating recipes used to coat fabrics intended for digital printing.
- The recipes were compiled into a document
- A universal recipe was devised based on this recipe list, input from Whaleys and Becky Hill (Digital Print Technician)
- The coatings were applied onto four different substrates (cotton, wool, linen, silk) in a variety of means (spray, screen print, immersion)
- These fabrics were then air dried and printed upon using the Mimaki TX2-1600 with reactive dyes, followed by normal steaming and washing processes
- The prints were documented and visual observations made

Screen printed

Uncoated area

Screen printed with pattern

Print made on cotton

Details of cotton satin print

Screen print Coated

uncoated

Screen printed with pattern

Print made on Linen

Details of juniper linen print

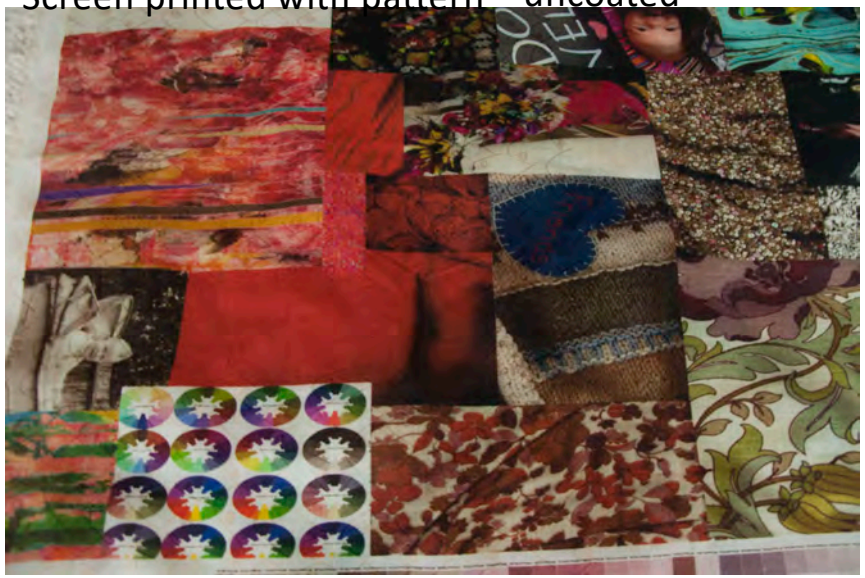
Screen printed uncoated Screen printed with pattern

Print on wool twill

Detail of print on wool twill

uncoated coated

Screen printed with pattern uncoated



Screen printed uncoated Screen printed with pattern

Print on satin silk

coated uncoated

Coated with pattern uncoated

Details of silk satin

coated uncoated

Spray coated

uncoated

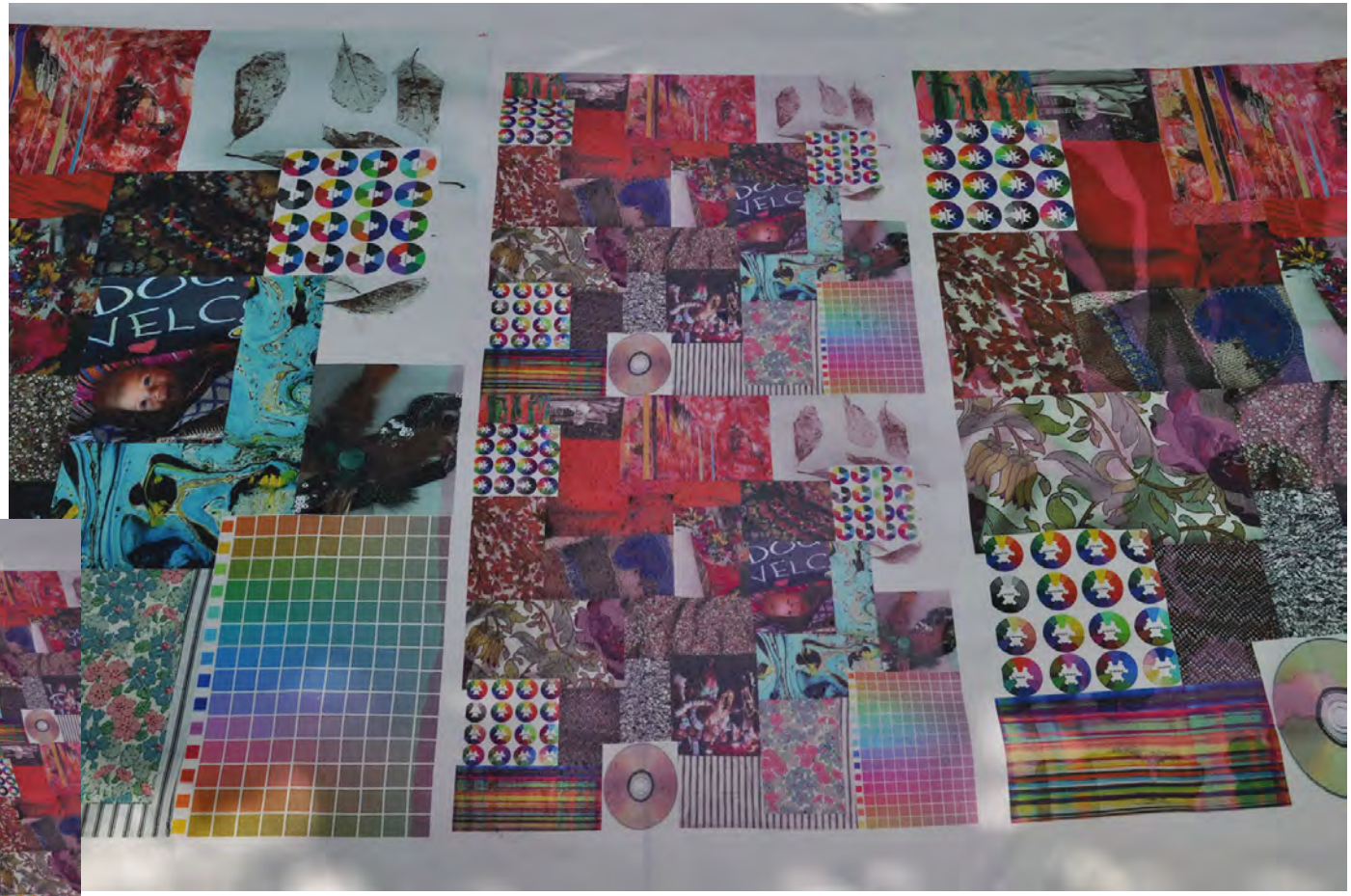
Screen printed with pattern

Print on Cotton Satin

Details of print on cotton satin

uncoated

Screen printed with pattern



Spray coated

Details of
Screen print
Pattern on cotton
Satin

Spray coated

uncoated

Screen printed with pattern

Details of print on cotton satin

Spray coated uncoated Screen printed with pattern

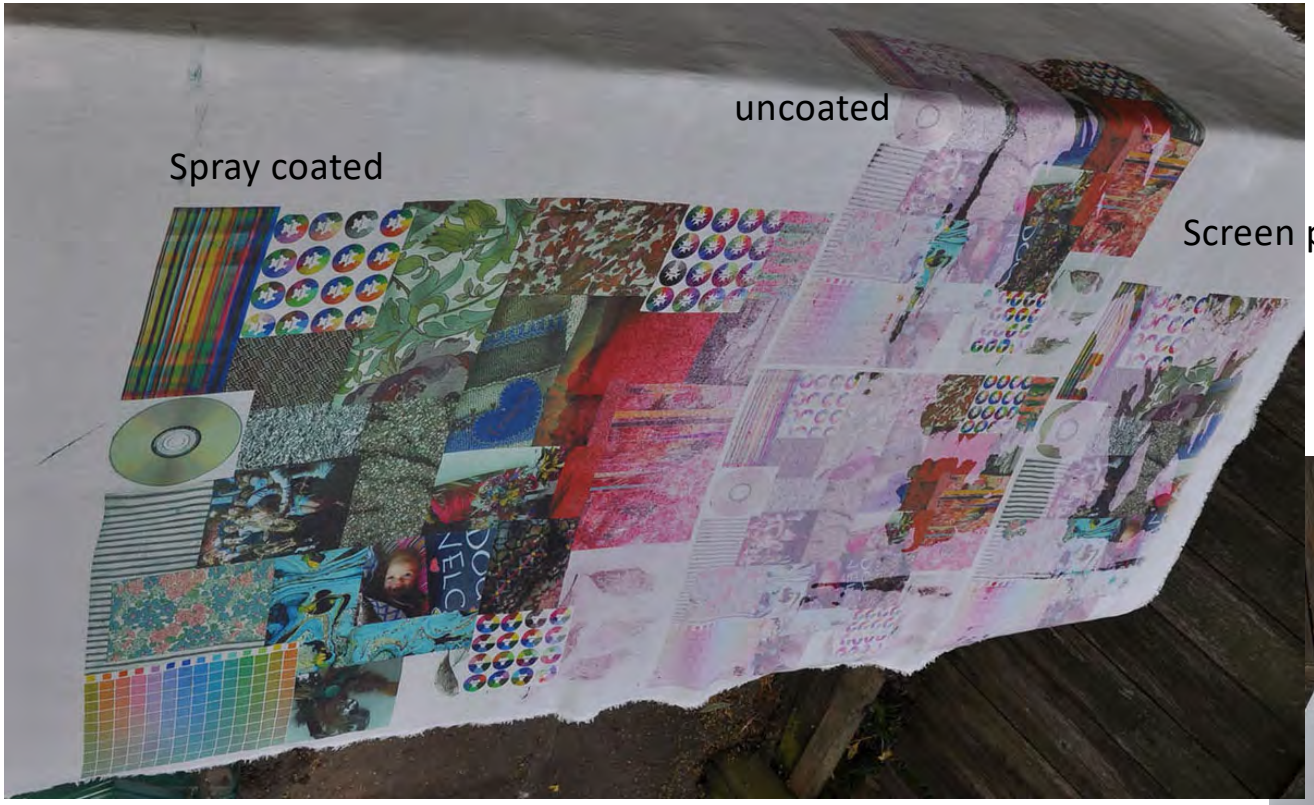
Print on wool twill – unfortunately the washing conditions used were not appropriate for wool and the fabric felted

Spray coated

uncoated

Screen printed with pattern

Detail of print on wool twill



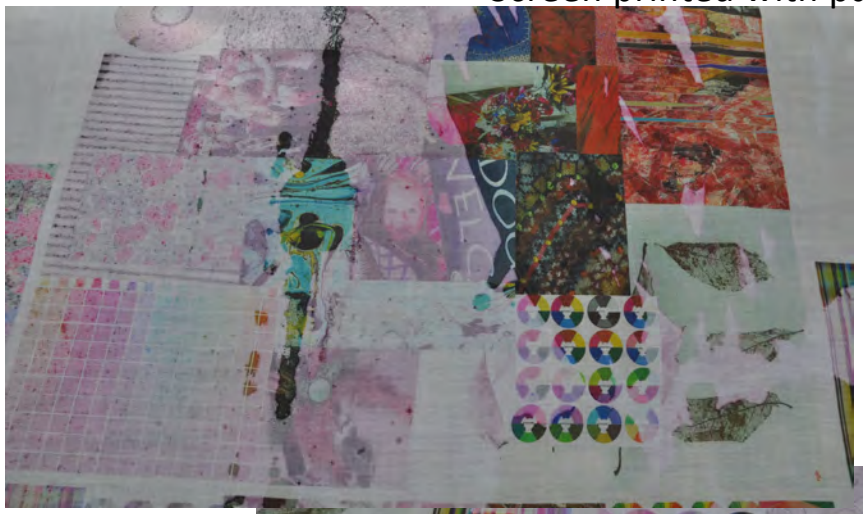
Screen printed on linen

Print on juniper linen

Spray coated

Uncoated

Screen printed with pattern



uncoated

Detail of juniper linen

Screen printed with pattern

Prints on juniper linen – the linen was much larger than the printer so the prints have been placed oddly

Spray coated

uncoated

Screen coated with pattern

Spray coated uncoated Screen printed with pattern

Print on silk satin

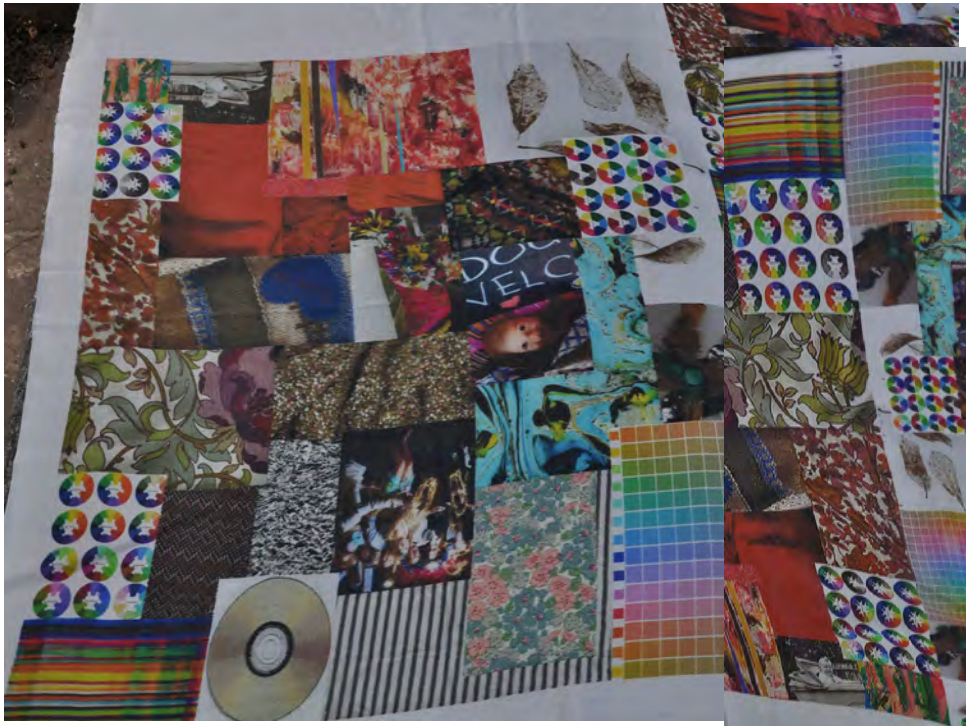
Spray coated

uncoated

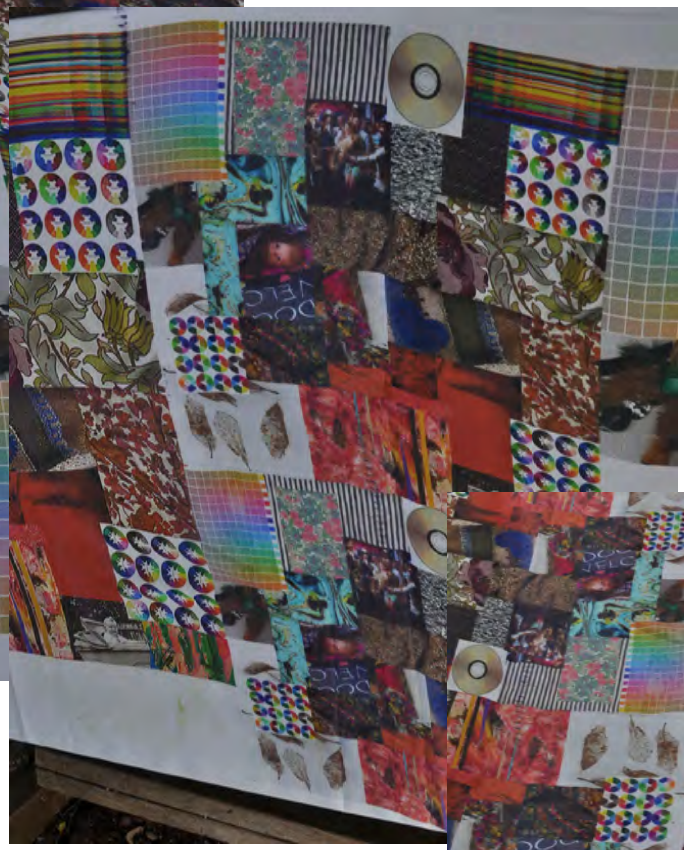
Screen printed with pattern

Detail of print on silk satin

Details of print on silk satin

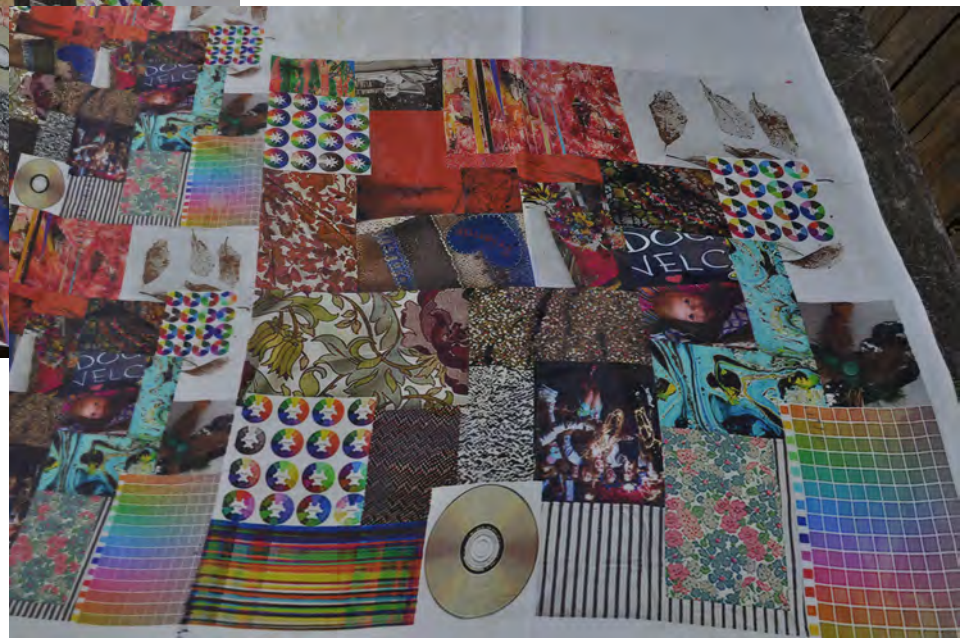


Spray coated



uncoated

Screen printed with pattern



Details of silk satin

Screen
Printed
With pattern

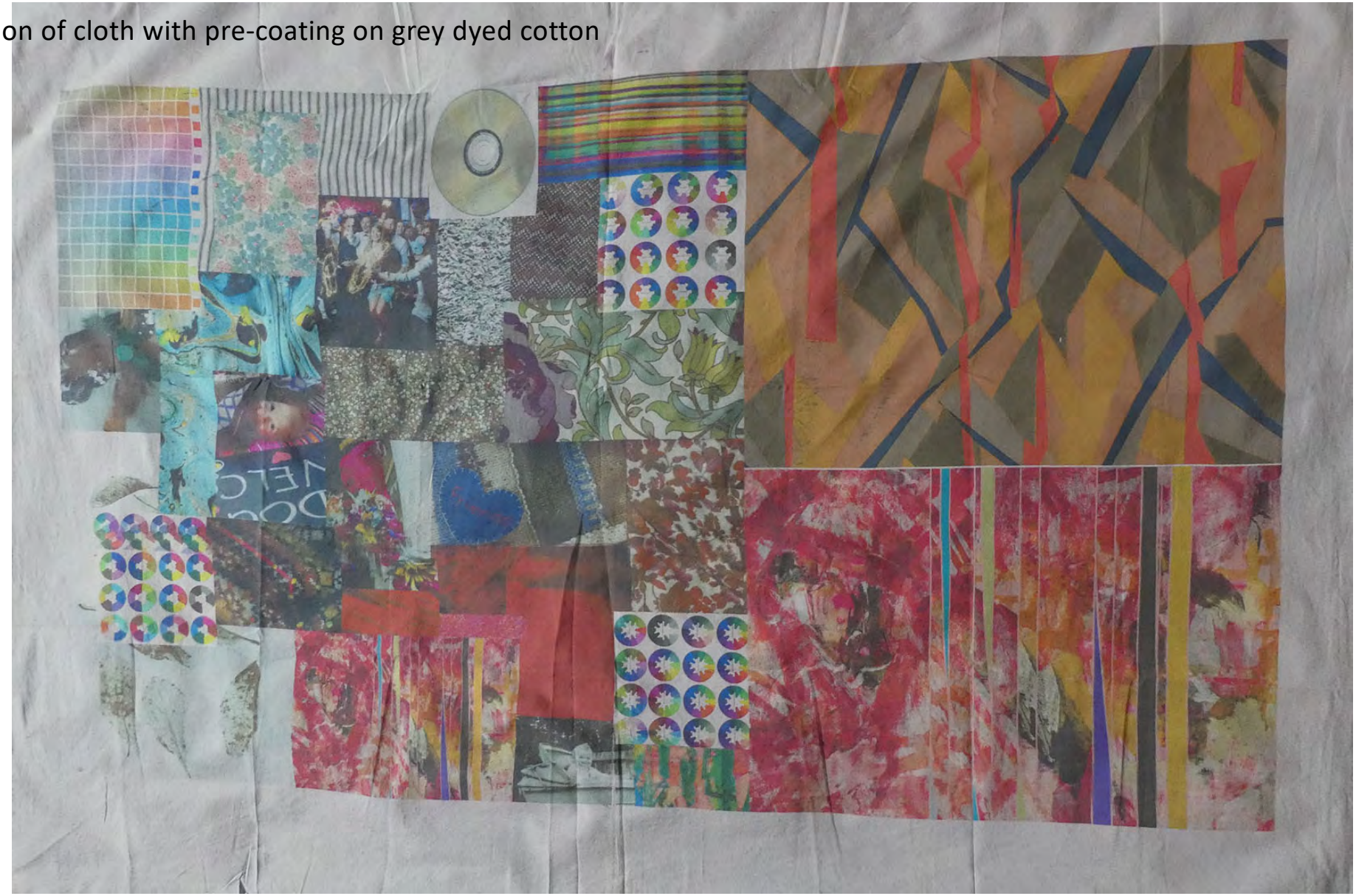
Spray coatec

uncoated

Immersion of cloth with pre-coating on yellow dyed cotton

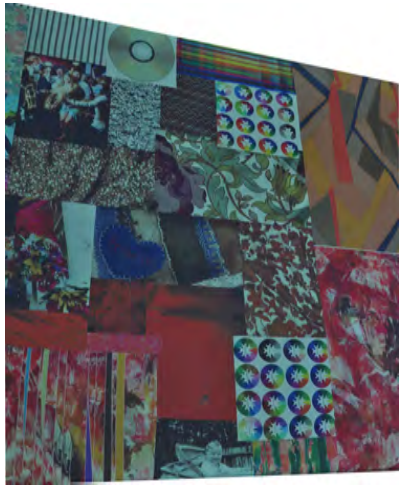
Immersion of cloth with pre-coating on green dyed cotton

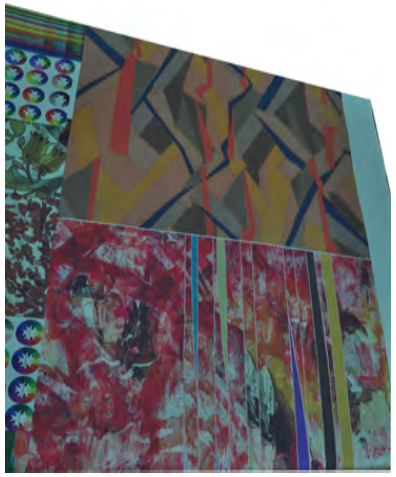
Immersion of cloth with pre-coating on grey dyed cotton



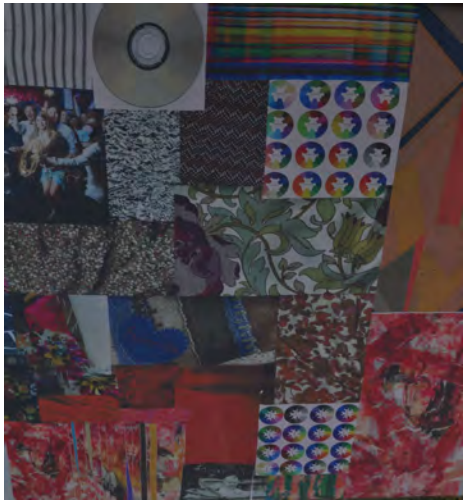
Immersion of cloth with pre-coating on bleached white cotton

Details of yellow





Details of green



Details of grey

Details of white

Observations

- The cellulose fabrics, particularly the linen, were greatly affected by whether the fabric was coated or not.
- All fabrics, including the protein, had an improved image quality where the fabric was coated
- It was hard to get an even coating using screen printing, spray printing and immersion required a lot of saturation of the fabric which gave a better outcome in print quality (both colour and image clarity)
- The coating left brown staining on the protein fabrics (wool and silk), which wasn't apparent for the cellulose fabrics
- The second set of patterned screen prints, with larger coated areas to the linear pattern first used, gave some really interesting aesthetic affects on the fabric
- The coloured fabrics which were immersed had a good print quality even though it was difficult to get an even distribution of coating. Immersion appeared to be the best method for applying a pad liquor (coating) but perhaps a roller / mangle mechanism could be applied afterwards to remove excess coating and aid drying
- The printed colours were hugely affected by using a coloured substrate. The grey in particular produced a really interesting quality to the colours. Digital prints have a reputation of appearing flat and where there are differences in saturation in the hues printed, can be jarring. However the grey gave a soft quality to the colour which was pleasing to the eye. Using a grey substrate could also help with textured fabrics where the print will not cover the entire fibre which leaves a white stub at the bottom which can be seen when the pile is touched or stroked. Grey is a good background colour for viewing fabrics against. Grey is also difficult to replicate using CMYK colorants.

Additional Information

- Different coatings could be mixed up which were better tailored to the substrate (protein or cellulose) and conditions (steaming type, washing conditions, humidity and temperature of the print environment) but a broad, more universal recipe was chosen to test instead.
- The photographs of the experiments were not taken under the same conditions (some outside, some inside) but used the same camera a Nikon D90 with no flash. Better photography (and a professional photographer!) would give a more accurate representation of the experiment results
- The wool twill which was spray coated was washed incorrectly and felted so it is difficult to judge image quality and in a way colour quality

What next

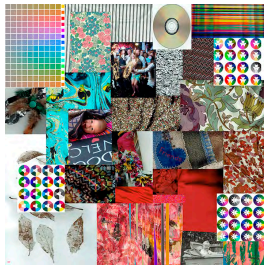
- An idea to test the coating mix in the Dimatix Materials Printer was proposed and became part of a 3 month Skills Development Training period, outside of the PhD, but funded through the 3D3 Centre for Doctoral Training
- The aim of the experiments with the DMP was to see whether the coating could be jetted through a print head in order to create interesting aesthetic affects between coated and uncoated areas, as well as economising the process by only coating areas that were to be printed upon
- The recipe used was altered to remove manutex which is a thickener, in order to have a chance of getting the solution through the print head nozzle which is very small
- The new solution was tested for stability and particle size which showed to be a good match with the requirements of the DMP.
- A drip test of the solution, filtered and unfiltered, was carried out to check that the coating solution still had the required colour enhancement properties, which was successful, although it was noted that the dye fixing was reduced perhaps as a result of losing the manutex
- Sadly the solution did not prove to be jettable, despite meeting the requirements of the DMP. It is unknown why but was presumed that although the particle size was small enough in tests, perhaps the particles re-gathered, in a process known as agitation, after filtration, and were unable to pass through the print head.
- The experiment was therefore disbanded.

- Further trials of grey substrate should be tested, particularly textured grey substrates. This might be something which becomes part of an exhibition of work to be shown as part of the project's thesis.
- Similarly a screen printed coating could be applied in a pattern on linen, which was the most affected, to create an interesting aesthetic affect

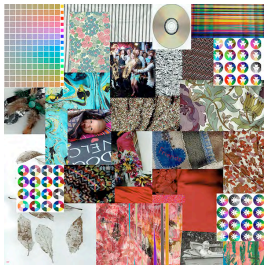
Colour Profiles

- A collage was created by the researcher which represented a range of colours using scanned images and items, digitally created designs, photographs and colour charts.
- This collage was then printed using an Epson Stylus DX400 printer, which uses Durabrite pigment inks, onto a bleached white cotton poplin.
- Each print used a different colour profile assigned in Adobe Photoshop
- The colour profiles selected were the top 8 most common colour profiles offered by Adobe Photoshop Creative Cloud. Each colour profile is listed underneath the photograph of the print. In addition 4 AVA profiles were assigned which are used by the Mimaki TX2-1600 inkjet textile printer.
- The photographs were taken inside in daylight by a Nikon SLR camera

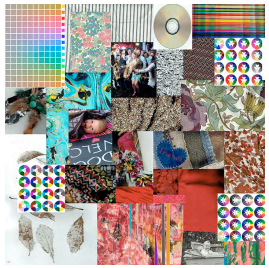
sRGB



Adobe RGB 1998



Apple RGB

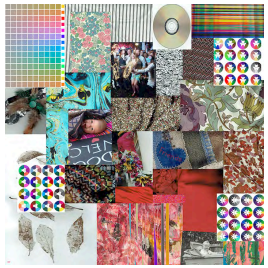


ColorMatch RGB

ProPhoto RGB

HDTV (rec 709)

SDTV NTSC



SDTV PAL

AVA Cotton

AVA Wool

AVA Silk

AVA Viscose

The profiles assigned to the display / screen image

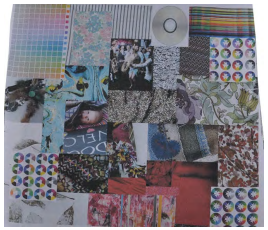
sRGB

Adobe RGB 1998

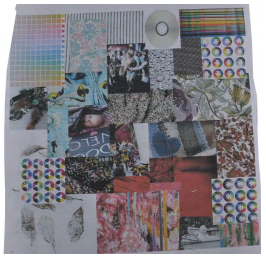
Apple RGB

ColorMatch RGB

ProPhoto RGB



HDTV (rec 709)



SDTV NTSC

SDTV PAL

AVA Cotton

AVA Wool

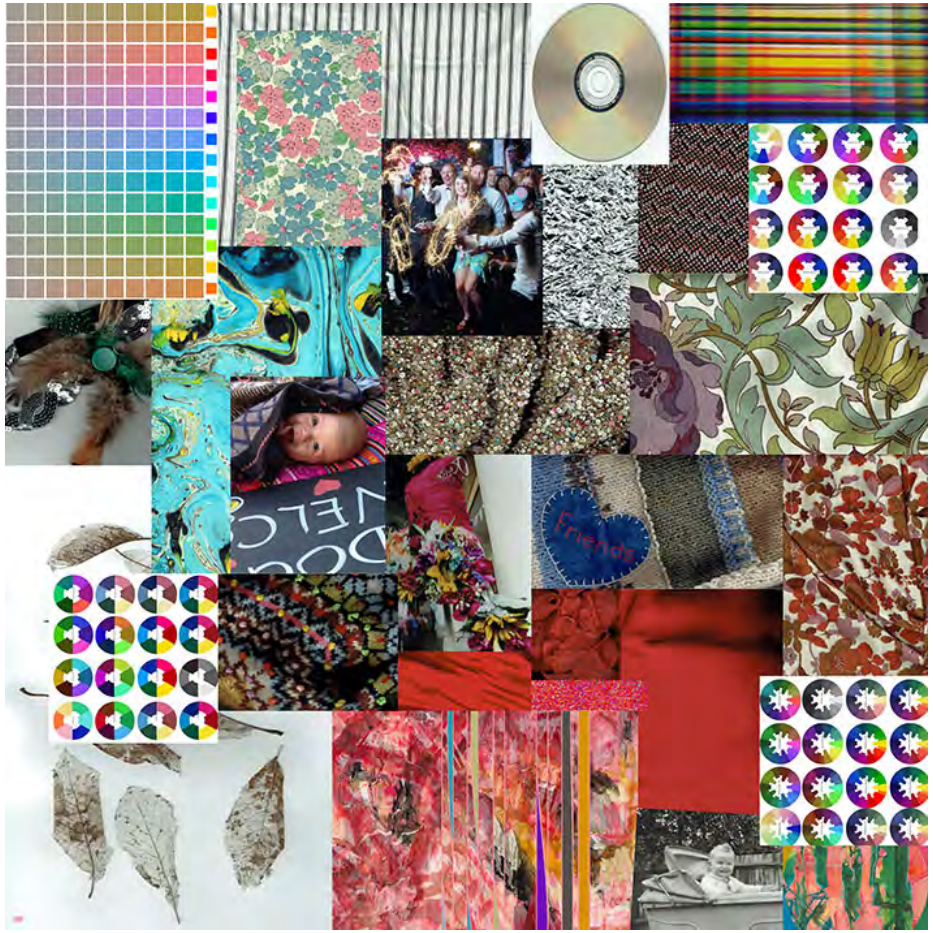
AVA Silk

AVA Viscose

The prints of the profiles on bleached cotton poplin

sRGB

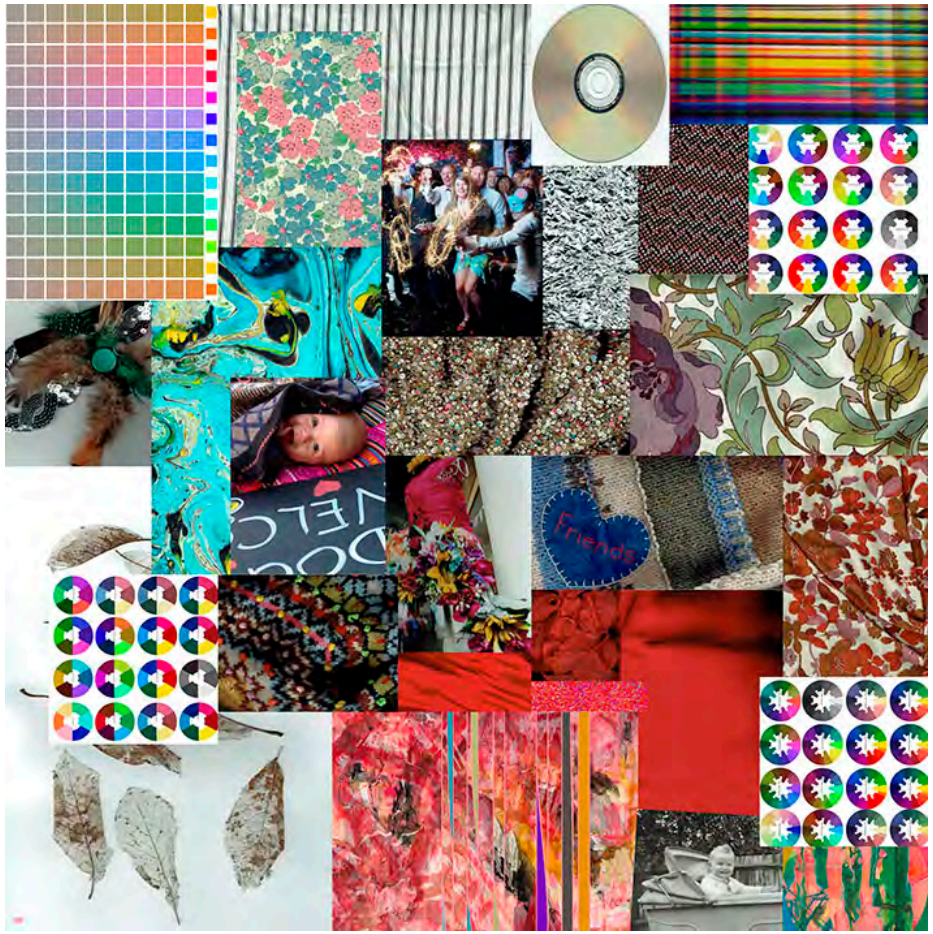
print



As seen on screen

Adobe RGB 1998

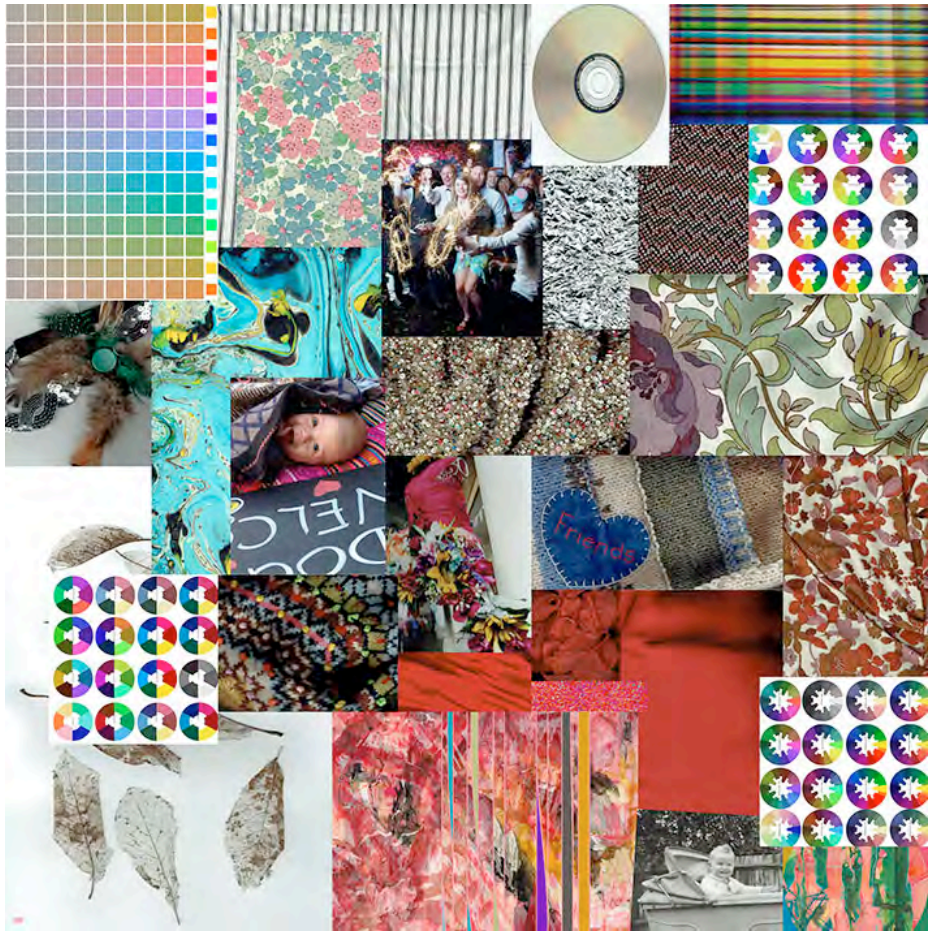
print



As seen on screen

Apple RGB

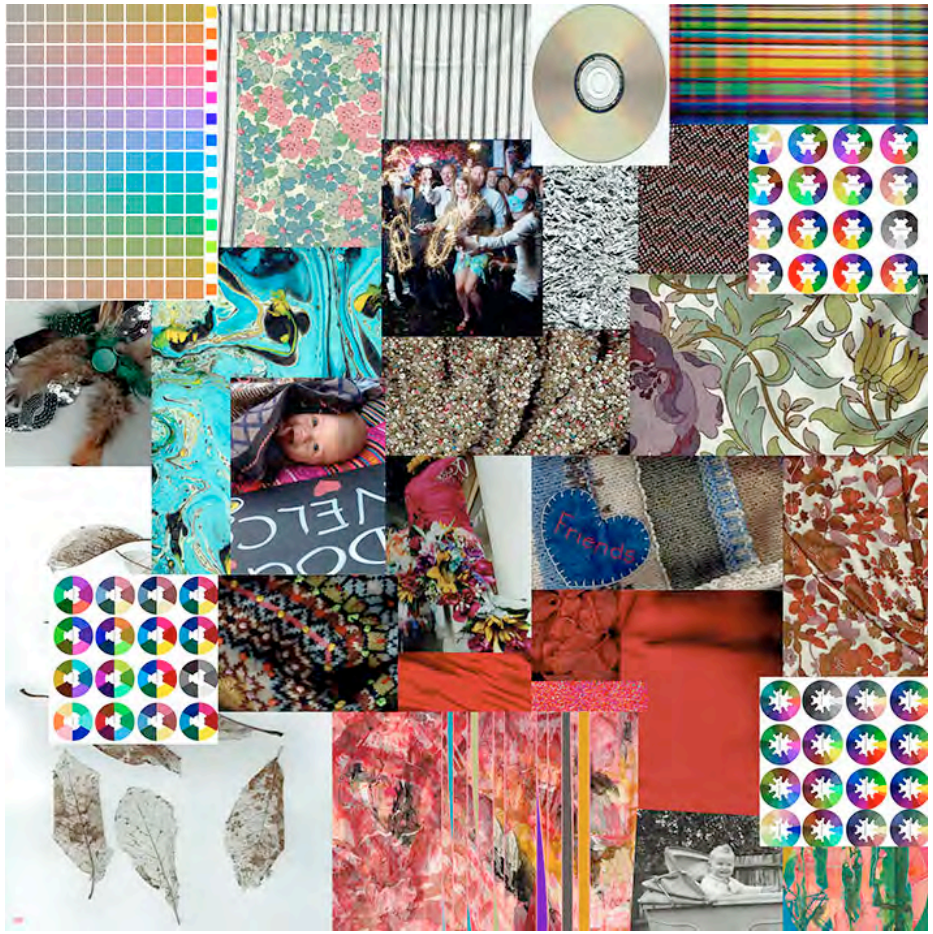
print



As seen on screen

Colour Match RGB

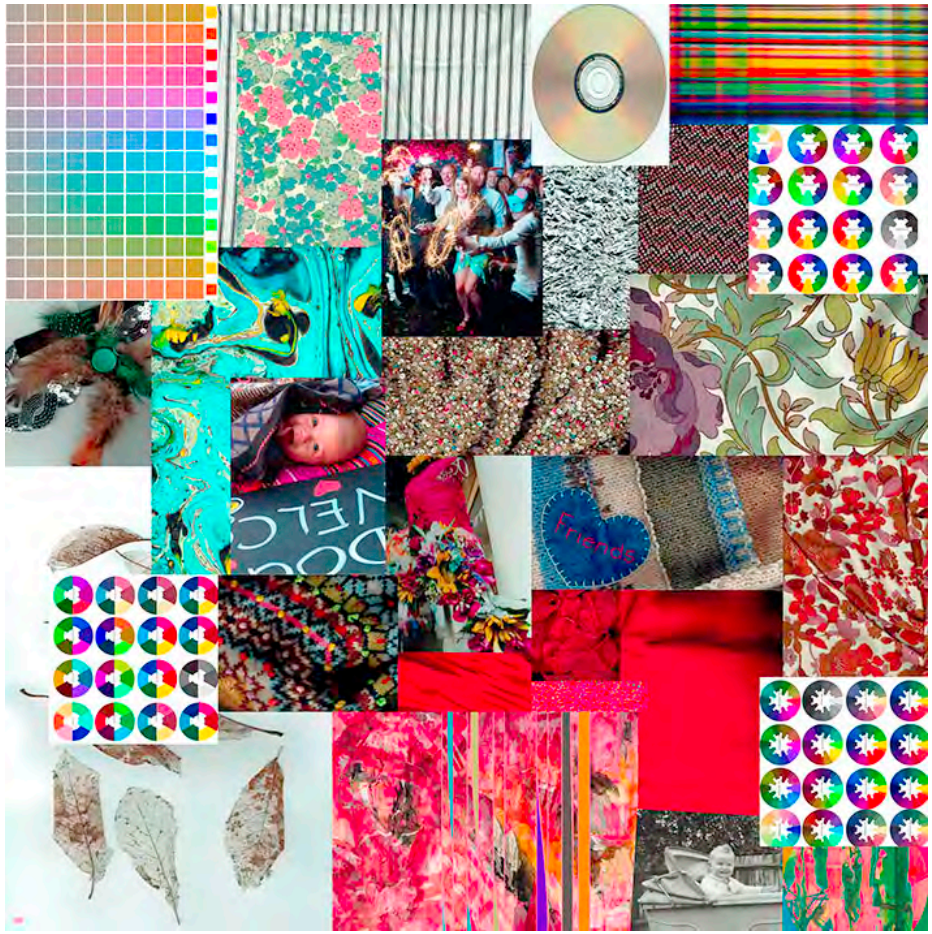
print



As seen on screen

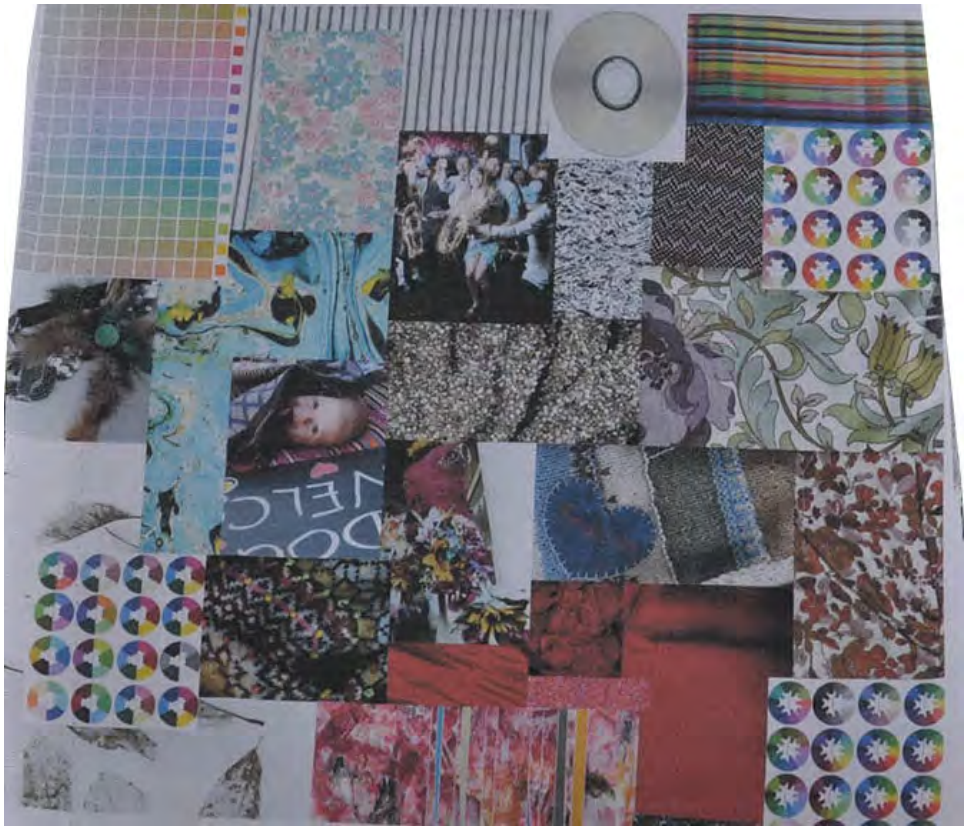
Pro Photo RGB

print

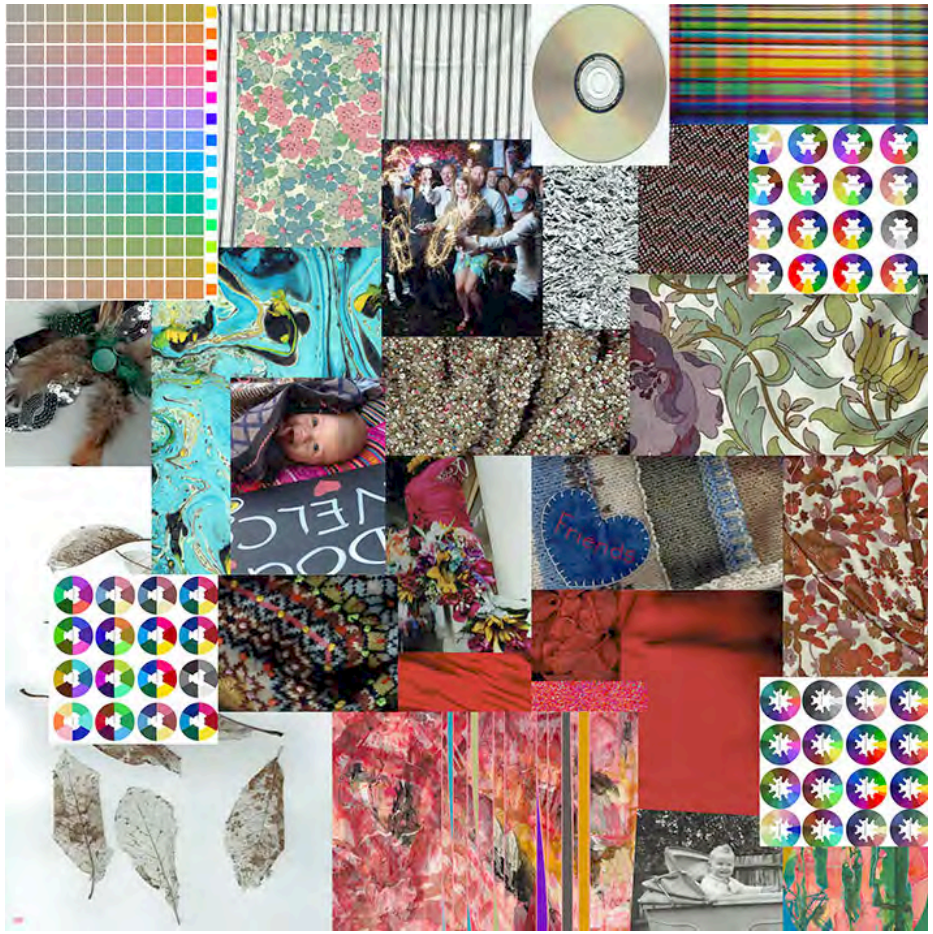


As seen on screen

HDTV Rec 709



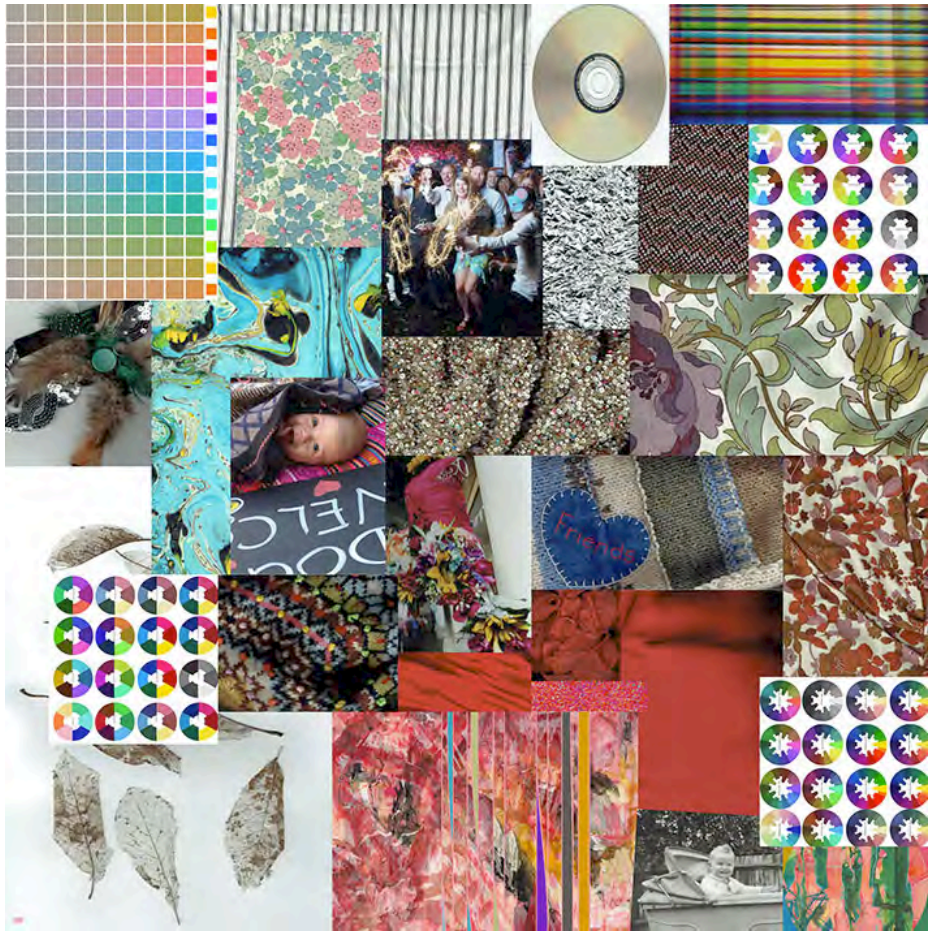
print



As seen on screen

SDTV NTSC

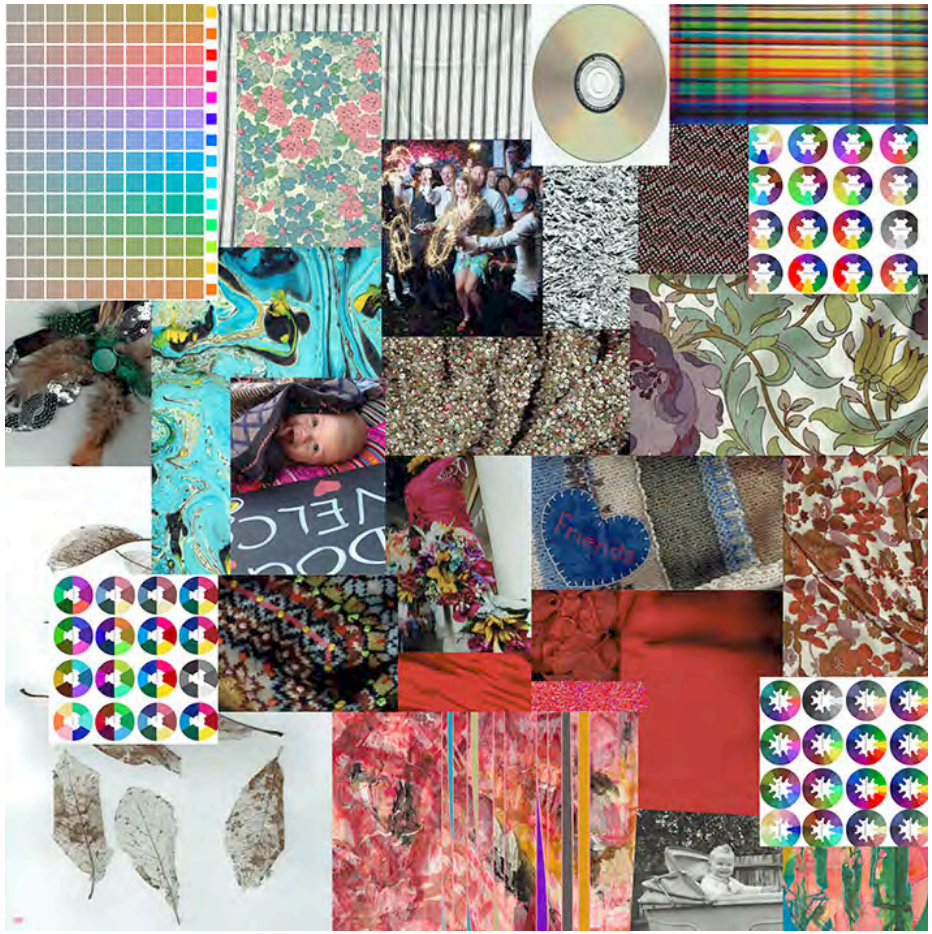
print



As seen on screen

SDTV PAL

print



As seen on screen

AVA Cotton

print

As seen on screen

AVA Wool

print

As seen on screen

AVA Silk

print

As seen on screen

AVA Viscose

print

As seen on screen

Observations

- It was easier to see the colour differences with the collages seen on screen as opposed to the prints
- The cotton poplin used was very thin (because the prints were made with an Epson home printer) and despite the fabric being white the photographs show the substrate as grey
- The AVA profiles produced the most extreme colour differences. These have been built specifically for the different substrates they are named after and try to compensate for the colour differences that each substrate will cause. This experiment demonstrated that supplying a designer with a print profile may not give them a real sense of how their image will appear when printed as they'll either view it on screen or print a proof which wont use the same print environment conditions of the DPB.
- Pro Photo RGB, a photography profile developed by Kodak, produced some really saturated, intense colours which Interesting lost a particular noise / darkening that tends to appear for printed yellows and oranges
- Adobe RGB 1998 and sRGB produced the best colour matches from print to screen, with Adobe RGB 1998 capable of producing the most saturated colours of the two. sRGB is a display profile which is not recommended for printing. Adobe RGB 1998 has the larger gamut and is recommended for assigning to images to be sent to print because it has as much colour information as possible included therefore if a colour is in the gamut of the printer it will not have been unecessarily clipped by assigning a smaller profile.
- The colour differences were frequently subtle but enough to change some colours very noticeably so perhaps designers could experiment with different profiles depending on their colour intentions?

What next

- Profile creation and Colour management systems were explored in a dedicated skills development training period for the project.
- A number of profiles were created by altering colour targets which were subsequently measured to create an ICC profile. These profiles intended to give a designer information, on screen, to how their image might print so that they could make corrections / amendments to design work to counter these
- The alterations to the colour targets were based upon data gathered through the production and measurement of a colour reference book
- Several print profiles were also created which have recently been tested to produce some prints for a work in progress show in January with 3D3
- The work was presented at the AIC 2018 conference in Lisbon, Portugal

No colour management

- Some prints were made using two different designs, a flat background print with simple shapes on top in CMYK primaries and a tonal design in 4 colourways.
- A print was made of these designs selecting no colour management in the RIP and a second comparison print made with normal colour management processes applied in the RIP

Tonal design

Top row: no colour management, Bottom row: RIP colour management processes applied

Tonal design

Top row: no colour management, Bottom row: RIP colour management processes applied

Flat colour design
Top row: no colour management, Bottom row: RIP colour management processes applied

Observations

- Interestingly the biggest colour changes are in the magenta and red hues. Darks and greens don't appear to be affected. There is a slight impact on cyans but not so much darker blues. Yellow tones have been affected also but again not so much as the magenta and red.
- The lack of colour management doesn't appear to be a complete disaster! Which makes you consider what colour management is actually doing, finely tweaking colours rather than drastically
- The black is blacker without colour management
- In some cases the image quality appears to be improved with no colour management
- Can you actually say that no colour management was applied when sending something to print through a Raster Image Processor? You are reliant on the RIP interface to say that there is no colour management. I'm sure the images, created in Photoshop without assigning a profile, will have embedded some information
- There is a greater amount of noise / speckle in the yellow without colour management
- Saturation of yellows decrease without colour management and increase for reds / magentas

What next

- Applying no colour management creates an interesting comparison. Perhaps useful for comparing the textile chemistry variables only?
- It would be good to test a design which had a wider variety of hues. The squares and circles test show that cyans are impacted by lack of colour management but the tonal design doesn't include many of these hues
- It would be helpful to have more information on what was happening within the RIP by selected to remove colour management processes and flag up any areas where colour management might 'accidentally' being applied and try to remove these and test again

Steaming Experiments

- Six test prints were made upon cotton satin using a Mimaki wide format inkjet textile printer and reactive dyes. They were then steamed at different intervals before undergoing normal washing conditions and compared.
- The shorter steams produced more vibrant colours, but the 60 minute steam the best colour match.
- The longer steam time led to dye bleeding. The print left unsteamed but washed demonstrated poor fixation.
- The print left unsteamed and not washed remained unfixed and the colours were noticeably duller and darker.

15 Minutes in Steamer,
Wash at 60 Degree

30 Minutes in Steamer,
Wash at 60 Degree

60 Minutes in Steamer,
Wash at 60 Degree

120 Minutes in Steamer,
Wash at 60 Degree

No Steaming,
Wash at 60 Degree

No Steaming,
No Wash

Observations

- The shorter steams produced more vibrant colours, but the 60 minute steam the best colour match.
- The longer steam time led to dye bleeding. The print left unsteamed but washed demonstrated poor fixation.
- The print left unsteamed and not washed remained unfixed and the colours were noticeably duller and darker.
- In current process we normally steam for an hour but perhaps this isn't required when really saturated colours are required? Steaming could be a way of managing colour outcome
- With reactive dyes some sort of fixation process is definietly required for the print to be useful, durable
- The humidity and temperature of the transfer between printer to steamer is not considered here

What next

- Tool kit could advise designers to question steaming and washing practices by their DPB and present these examples as a reason why
- UWE processes could use this info to get more saturated prints when required

Interwar Palette and archive experiments

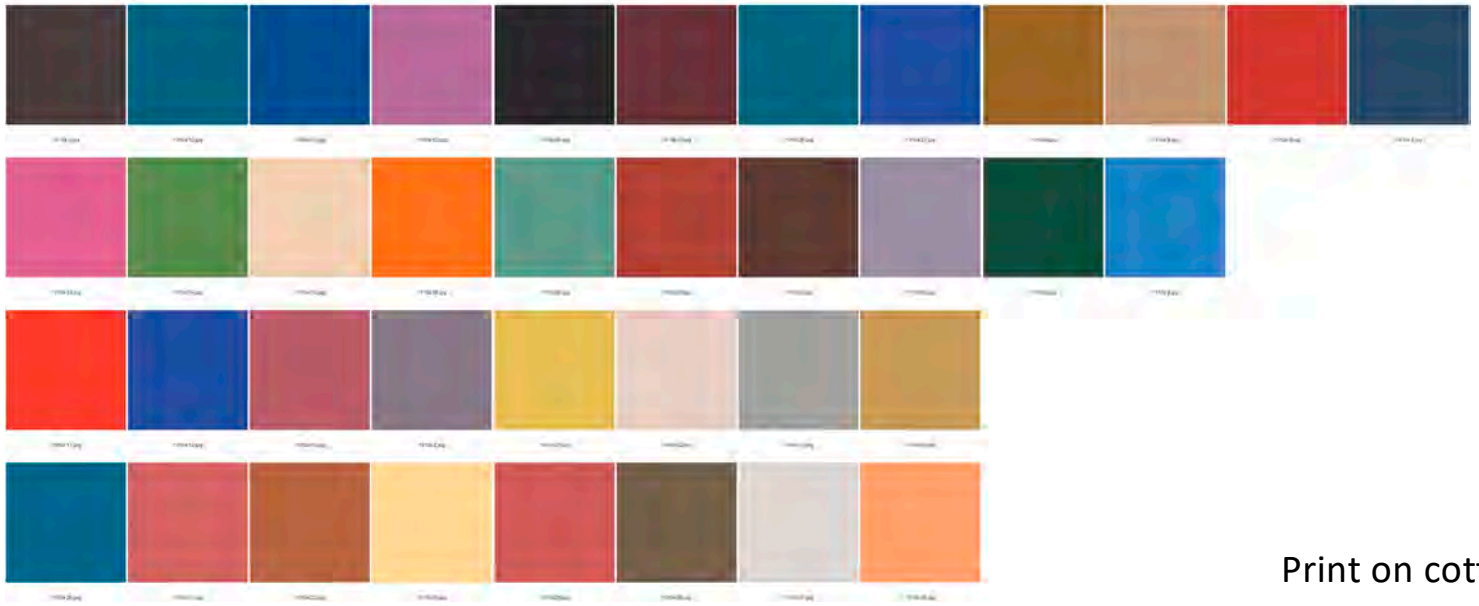
- As part of the exploration of colours from the interwar period a set of colour palettes were identified for 1910s, 1920s

1930s and 1940s using the Pantone History of Colour. The book is USA based so only colours that were international, rather

than specifically USA culture influenced were gathered. These were printed onto cotton satin.

- Several photographs of fabric swatches from the Crysede Archive, Penlee Museum, a fashion house in the 1920s and 30s

in Cornwall, were pixelated in Adobe Photoshop to identify the main colours being used. These were printed onto cotton satin and annotated



CAD File

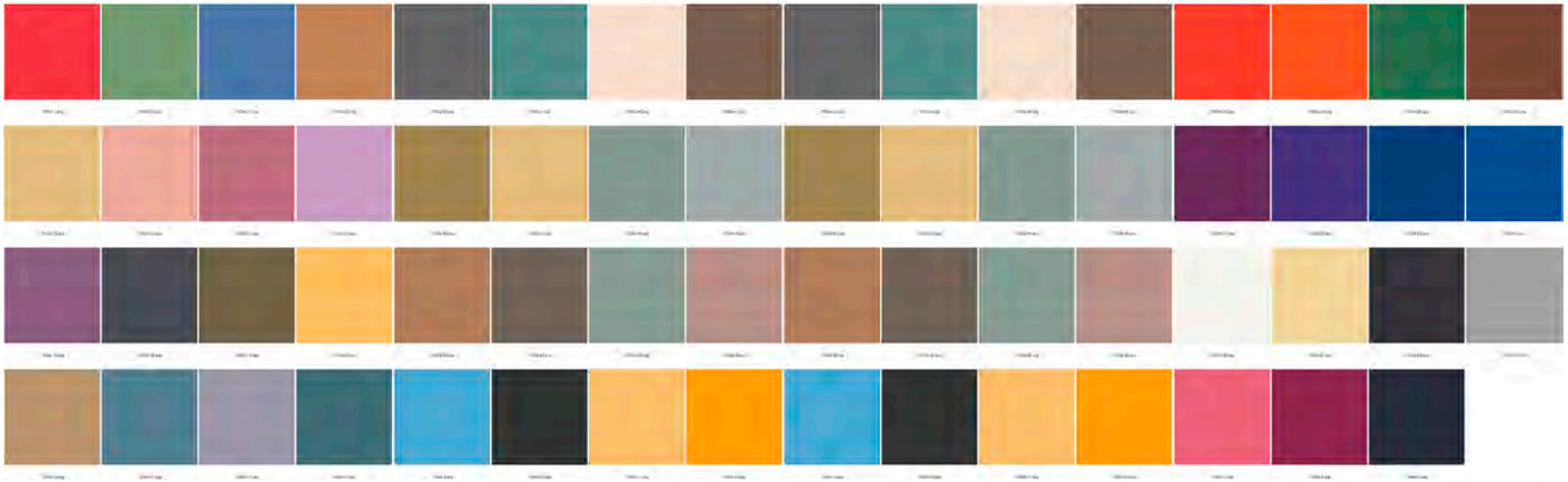
Print on cotton satin

1910s

CAD File

Print on cotton satin

1920s



CAD File

1930s

Print on
Cotton satin

CAD File

Print on Cotton Satin

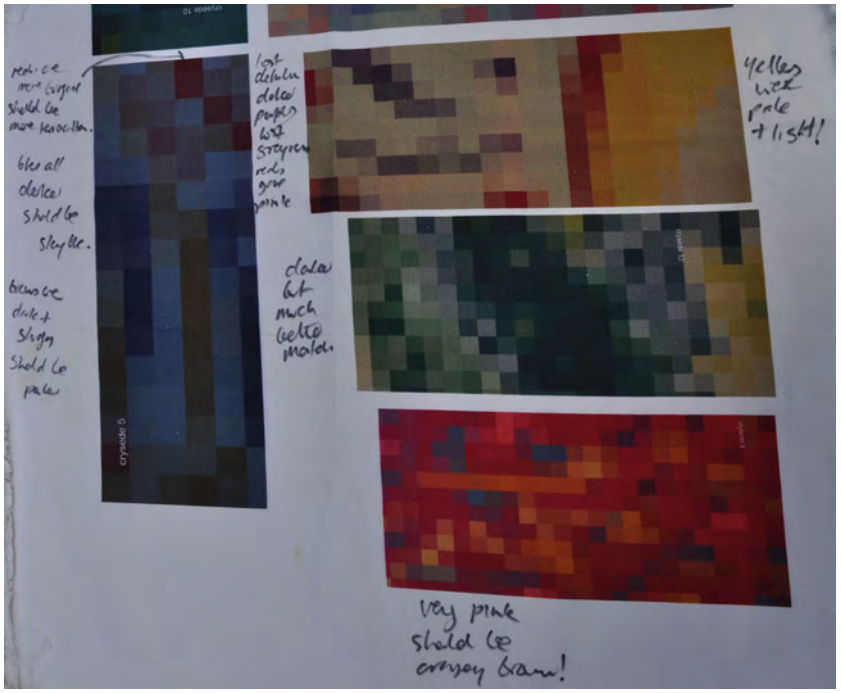
1940s

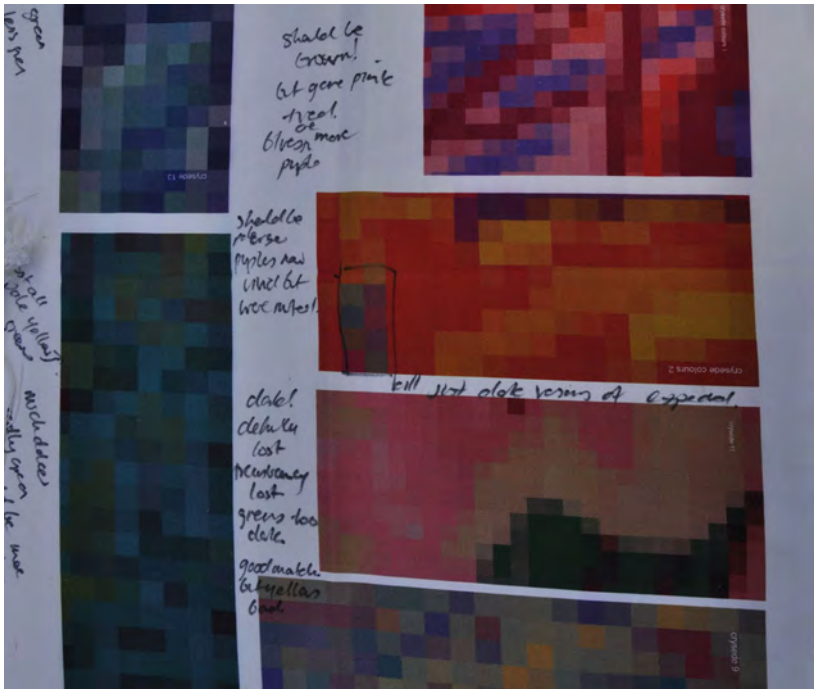
good match but orange too dark + yellow too dark
should be
brown!
but more pink
-ish!
or more
green
should be more
purple
dark!
darker
last
green too
dark.
good match
but yellow
too dark
yellow
too pale
+ light
very pink
should be
orangey brown!

much darker
really green
should be more
blue/green
darker!
definitely
lost
translucency
lost
greens too
dark.
good match
but yellow
too!
crysede 10
reduce
more urgent
should be
more ferocious.
blue all
darker
should be
sleyelle.
crysede 5
lost
definitely
darker
purple
but
strayer
reds
pink
greens
darker
but
much
better
match.
very pink
should be
orangey

green
less pen
should be
Green!
but more pink
+ teal
be
Bluer more
purple
crysede 13
should be
reverse
purples now
WAY but
more mutes!
full
lost all
the pale yellow
green
much darker
really green
should be more
blue/green
darker!
definitely
lost
translucency
lost
greens too
dark.
good match
but yellow
too!
crysede 10
reduce
more urgent
should be
more ferocious.
blue all
darker
should be
lost
definitely
darker
purple
but
strayer
reds
pink

green
less pen
definitely
crysede 4
much darker
all over
lost - subtle
ones
+ more ayer
+ real looks.
full
multi darker!
more green
less pen
good match
but more too
crysede 13
should be
Green!
but more pink
+ teal
be
Bluer more
purple
should be
reverse
purples now
WAY but
more mutes!
full
darker!
definitely
lost


reduce more orgeat should be more terracotta.
like all darker should be slightly.
brown be darker shiny should be pale
light definitely dotted purple but greyer reds gone pink
yellow not pale + light!
darker but much better match.
very pink should be orangey brown!


should be greyer! bit green pink + teal! be more blue + more purple.
should be more purples and much bit more intense!
dark! definitely lost green too dark.
good match to yellow but

crysede 4
crysede 6
crysede colours 3
should be
1 dark shades
much darker
all the
lost-subtle
hues
+ more over
1 real looks.
good match bt greys too dark + yellow too dark
Shadol be

crysede 4
crysede 13
crysede colours 3
all the
lost-subtle
hues
+ more over
1 real looks.
good match bt greys too dark + yellow too dark
multi-dated.
more green
less pen
Shadol be
Grown!
bt gere pink
tread.
be
Blues more
pyde
Shadolbe
reverse
pyples now
what bt
wee mutes!

Observations

- There are some obvious differences between screen and print colour with these interwar colour palettes. Particularly for the sludgier greens, reds and pinks. Perhaps this is because their grey content is high and CMYK printing struggles to replicate grey?
- The 1910s-30s contain a lot of bright colours I wouldn't have necessarily associated with these eras
- I really like the colour combinations but the prints do not reflect the hues chosen which supports the hypothesis that interwar colours would be good to test as they are difficult to replicate

- I really like how the pixelated the crysede photos have turned out
- All the colours appeared duller than on screen and many of the colours became pinker / redder than as seen on screen
- The best colour matches were in the prints which contained a lot of pastel blue

What next

- The pantone colour palettes were used to develop a series of designs which were printed onto cotton satin
- These palettes could be further refined to highlight the less printable / replicable colours and combined with some of the profiles that have been created to see whether that improves colour matching
- It would be interesting to test these colour palettes onto coloured substrates – see previous coating experiments

- Pixelating the cryesede images produced some really interesteing aesthetic affects. This could be a way of referencing the archives that have been used and the design style and influences from the interwar but updating them to a modern setting

Unprintable Colours

- A set of colours that Adobe Photoshop flagged as out of gamut were printed onto cotton satin using a Mimaki TX2-1600
- Digital textile inkjet printer with Reactive Dyes
- The CAD file and printed version were compared

CAD File

Unprintable colours printed onto cotton satin

Observations

- All the printed colours decreased in saturation
- The greens lost some of the yellowness but were the best match of the set
- Pinks and purples became duller, more muted, greyer
- The blues became darker
- The pink reds became darker
- The orange reds became darker but it was also difficult to differentiate between them
- Dark purples look black and again difficult to decipher between dark purples and dark blues

What next

- This work led to the creation of a colour reference book which tested 1137 colours printed onto 4 different substrates and examined the data behind their digital creation
- Photoshop's out of gamut warning tool was also assessed, with the finding that actually achromatic colours which are not flagged as out of gamut are harder to replicate and that colour management processes ensured a better than expected colour match for many of the hues flagged as out of gamut.
- The colour reference book also highlighted the affect that the substrate had on colour outcome

- It should be considered whether a profile supplied by a DPB could be used in conjunction with Adobe Photoshops out of gamut warning tool to see whether this could be used as a method of flagging to designers colours which really will be out of a printers gamut. This test should therefore be repeated using a set of colours flagged as out of gamut for AVA across the 4 different profiles (related to substrate) in photoshop and then printed.

Big Colour Swatches

- Using the Colour Reference Book, visual observations were made where particular colours stood out as being poor matches
- These were enlarged and printed across different substrates and presented at the 3D3 meeting November 2016

Print on Cotton

Pantone 1101
Pantone 1103
Pantone 529
Pantone 518
Pantone 510
Pantone 339
Pantone 328
Pantone 327
Pantone 390
Pantone 389
Pantone 496
Pantone 455
Pantone 793
Pantone 770
Pantone 416
Pantone 409
Pantone 041
Pantone 027
Pantone 053
Pantone 064
Pantone 648
Pantone 633
Pantone 160
Pantone 149
Pantone 144
Pantone 940
Pantone 986
Pantone 989
Pantone 673
Pantone 693
Pantone 671
Pantone 691
Pantone 673
Pantone 677

Pantone 1101
Pantone 1103
Pantone 529
Pantone 518
Pantone 510
Pantone 339
Pantone 328
Pantone 327
Pantone 390
Pantone 389
Pantone 496
Pantone 455
Pantone 793
Pantone 770
Pantone 416
Pantone 409
Pantone 041
Pantone 027
Pantone 053
Pantone 064
Pantone 648
Pantone 633
Pantone 621
Pantone 619
Pantone 160
Pantone 149
Pantone 144
Pantone 940
Pantone 986
Pantone 989
Pantone 673
Pantone 693
Pantone 671
Pantone 691
Pantone 673
Pantone 677
Print on Wool

Pantone Process Yellow
Pantone Process Magenta
Pantone Process Cyan
Pantone Process Black
Pantone 1101
Pantone 1103
Pantone 529
Pantone 518
Pantone 510
Pantone 339
Pantone 328
Pantone 327
Pantone 390
Pantone 389
Pantone 496
Pantone 455
Pantone 793
Pantone 770
Pantone 416
Pantone 409
Pantone 041
Pantone 027
Pantone 053
Pantone 064
Pantone 648
Pantone 633
Pantone 160
Pantone 149
Pantone 144
Pantone 940
Pantone 986
Pantone 989
Pantone 673
Pantone 693
Pantone 671
Pantone 691
Pantone 673
Pantone 677

Pantone Process Yellow
Pantone Process Magenta
Pantone Process Cyan
Pantone Process Black
Pantone 1101
Pantone 1103
Pantone 529
Pantone 518
Pantone 510
Pantone 339
Pantone 328
Pantone 327
Pantone 390
Pantone 389
Pantone 496
Pantone 455
Pantone 793
Pantone 770
Pantone 416
Pantone 409
Pantone 041
Pantone 027
Pantone 053
Pantone 064
Pantone 648
Pantone 633
Pantone 621
Pantone 619
Pantone 160
Pantone 149
Pantone 144
Pantone 940
Pantone 986
Pantone 989
Pantone 673
Pantone 693
Pantone 671
Pantone 691
Pantone 673
Pantone 677
Print on Linen

Print on Silk

Observations

- These selections were based purely on visual observations of the smaller swatches to where the biggest colour differences were happening
- You can really see this with the yellow/ yellow greens / yellow oranges
- You can also see clearly that the greys are very different between each substrate
- The purples in the wool are much bluer than any of the others
- The pinks are not too bad a match
- Even the process colours (top row first 4) are different to screen although the colour match between the substrates is good
- The pastels lose some of their warmth when printed. They all appear greyer and duller in the prints

- These results are a bit different to the conclusions of the colour reference book which found that blues, magentas and achromatics had the biggest screen to print differences but didn't find so in the yellow
- Has the scaled influenced this conclusion, the colour reference swatches are much smaller (2cm by 2cm) The squares here are at least 5cm by 5cm

What next

- The scale and lack of colour match between the yellows was not something considered with the work on the colour reference book
- Further work on achromatic colours was suggested, particularly greys, so scale needs to be considered when taking this forward
- Yellows will also need to be revisited as they are clearly very different here. It has always been noted that yellows produced by this print environment appear noisy / speckled
- Microscope work on these might offer reasons to why the dither is producing ‘off’ colours

Double Pass Prints

- a digital textile print is normally completed in a single pass, although print heads will build density by overprinting dots in the dithered matrix which gives the perception of colour and image
- an experiment was conducted where two designs were over printed by separating out layers so that a foundation layer was first printed and then the fabric fed back into the machine and a second layer printed on top
- the first design was a simple flat background, using CMYK primaries which was printed first, and the second layer a series of dots consisting of the other primaries. The overlapping colour was observed and reflected upon.
- the second design was a tonal image which was loosely divided into four colour layers. The first two layers were printed together in the first pass, and the second two in a second pass. The scale of the second two layers was slightly enlarged to ensure that some overlapping would occur. The results were observed and reflected upon.

Single pass print

Double Pass print

The flat background was printed first, the circles overprinted on top

Double pass print using two different ICC profiles. Top: Adobe RGB 1998, Bottom: sRGB

Single pass print

Double pass print

Single pass print

Double pass print

Single pass print

Double pass print

Single pass print

Double pass print

Observations

- There are some real colour differences to be observed between the double pass print and the single pass print.
- The blacks are much blacker, black has been cited as a difficult to get a good match or deep enough shades
- As there is no white dye you lose any white in the second layer printed. This is particularly noticeable in the squares and circles print
- It is difficult to see if the double pass improves on colour quality or colour matching with the tonal design. It is easier to see with the squares and circle prints.
- Obviously paler colours such as yellows also lose their colour quality. Again this can be clearly seen in the squares and circles print

- Tonal Design - Scaling up the second layer has produced some overlapping fugitive colours which were unpredicatable to how they would appear
- Tonal Design - Although this has lost some of the background image which is a shame
- Tonal Design - Where there are overlaps the prints do appear less flat and I like the aesthetics where you get a bit more of a 3D effect from the overlapping. You can see this best on the third print using CMYK colour way. The black overlaid on the magenta and cyan really pops out

What next

- The aesthetic 3D effect of layering could be further developed but perhaps with a coloured substrate being used or the first layer being laid down with a lot of the background included so that there was better coverage
- If printing more passes then the order of layers and the colours they include need to be really considered as with silk screen printing, with paler colours printed first

- Further experiments were conducted with triple pass printing

Triple pass printing

- the pass printing experiment was repeated for one design but this time the design was seperated into three layers with the darkest layer printed first
- the different layers were scaled up so that there was some overlapping
- the original design was printed in a single pass, as normal, as a comparison
- a third print was made, in a single pass, but the design used the three separate layers placed on top of each other, at different scales, to compare the overlap effect with physical overlaps of the tripple pass
- the results were observed and reflected upon

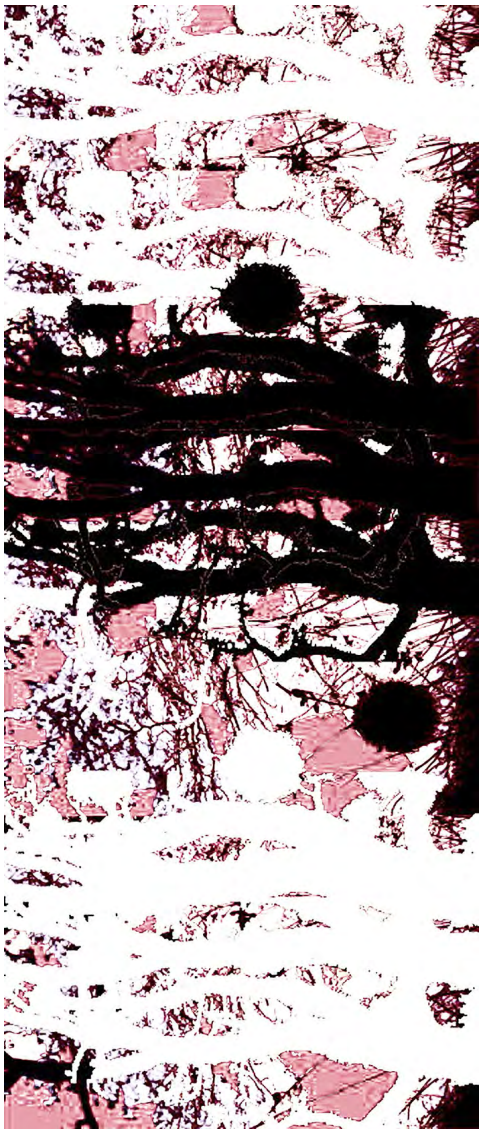
Design printed in a single pass

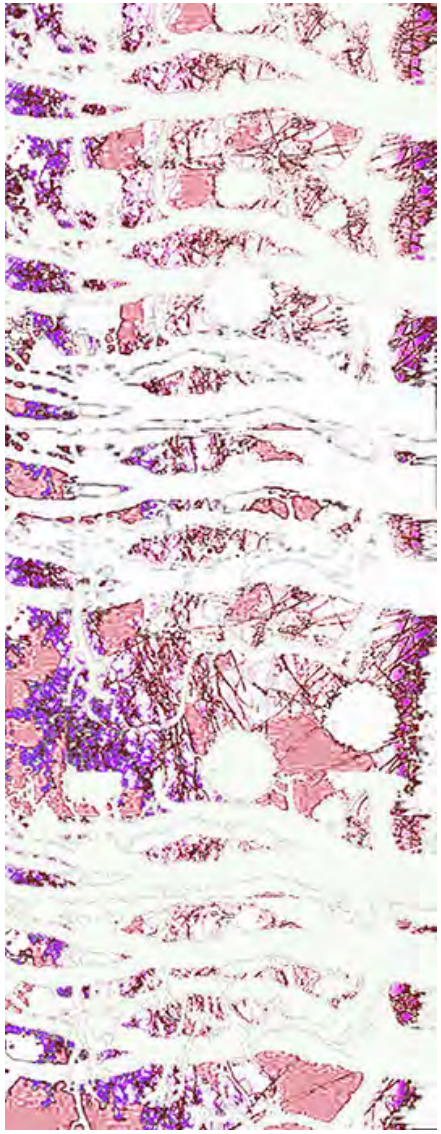
Details of single pass print

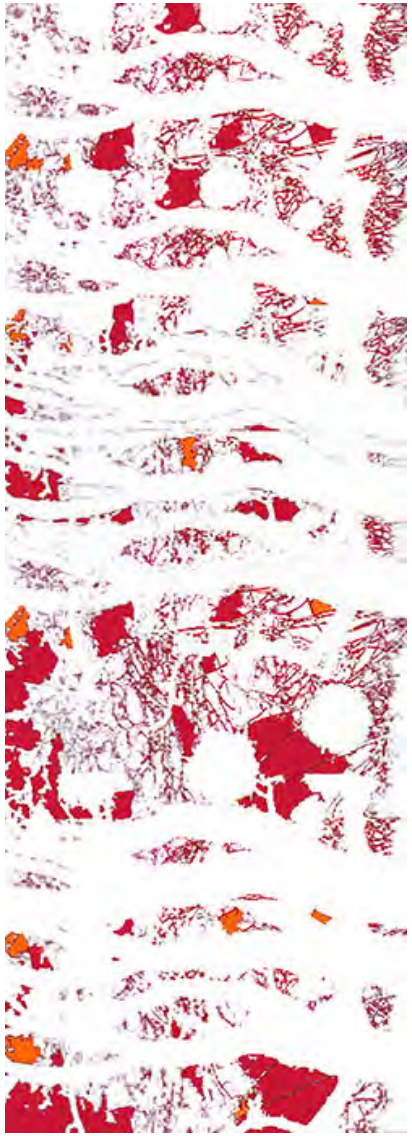
triple pass print – layers seperated into reds, pinks, and blacks. Black layer printed first

Details of three pass print

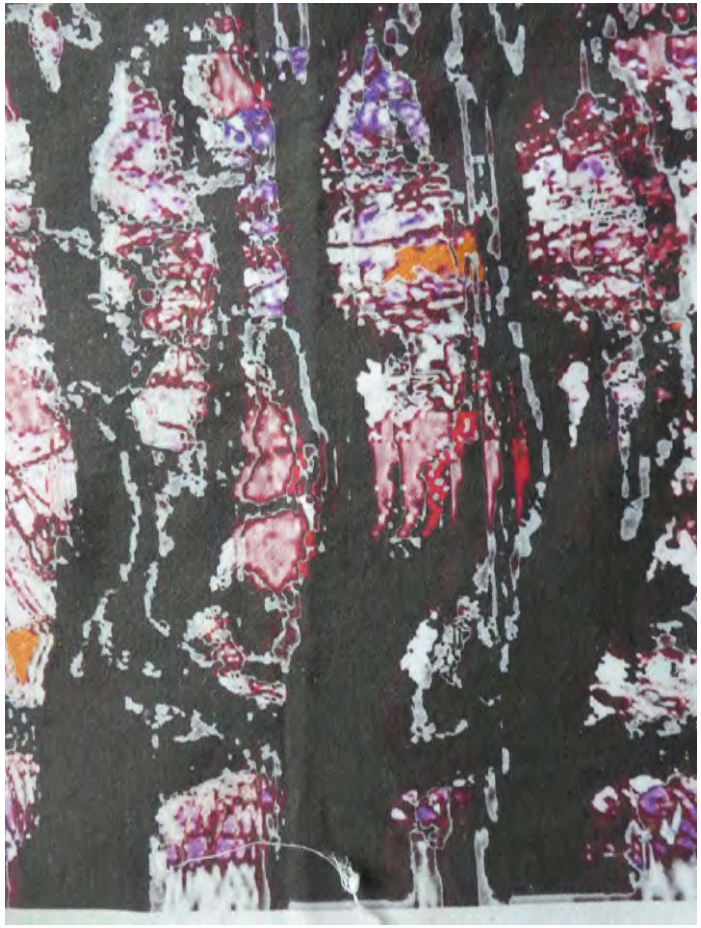
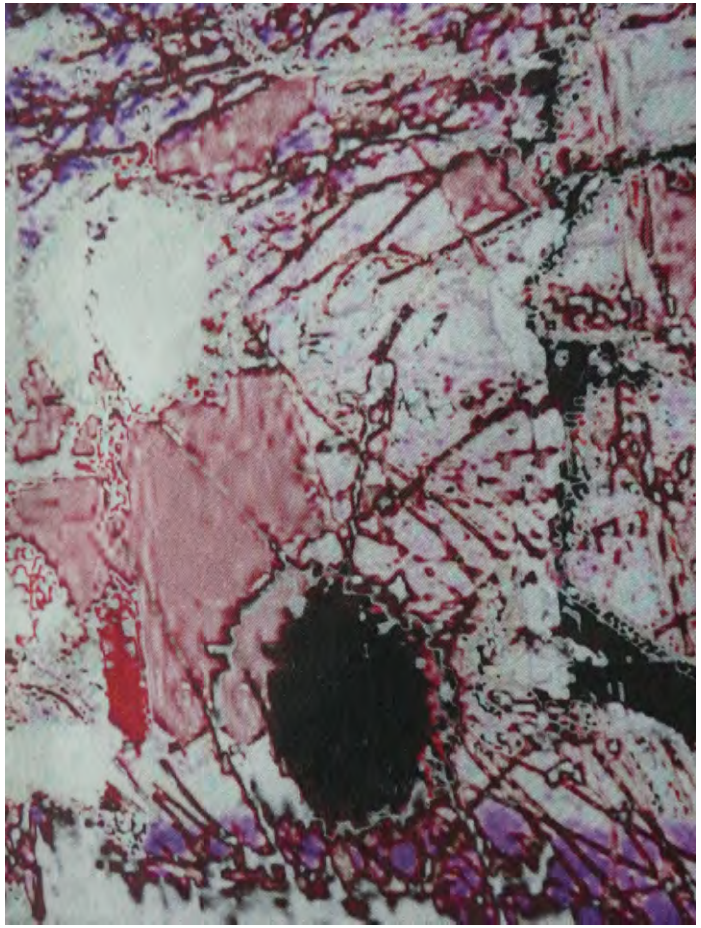
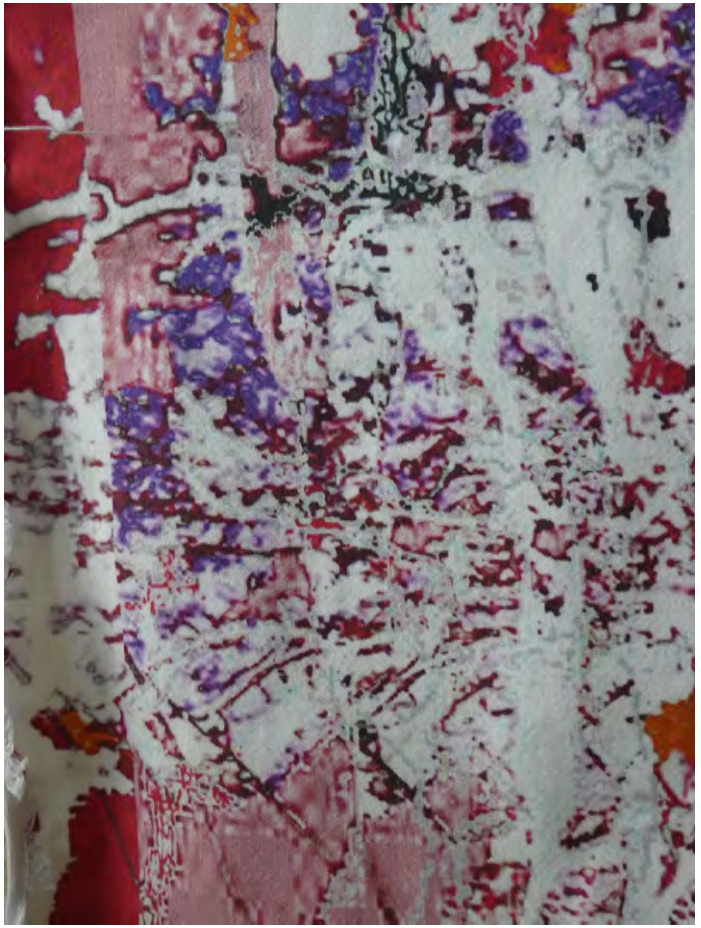
The three different layers







The three layers in the design flattened together in photoshop and printed in a single pass

Detail of flattened, scaled layers printed in single pass

Observations

- This print worked much better than the double pass prints. This I think is because the layers were better considered
- The darker layer was printed first which goes against the recommendations from the first experiment
- The colour aesthetics (depth, layering) had a really nice quality to them. Particularly around the darker colours. I really liked how the black areas became almost brown when the second and third layers were applied
- This process is going to be more expensive because the dyes are costly and you are building up dye on top of dye
- The third print, a comparison one where the scaled up layers were flattened in photoshop and printed in a single pass, lose the aesthetic depth and warmth the triple pass print provides
- The colours are deeper in the triple pass print

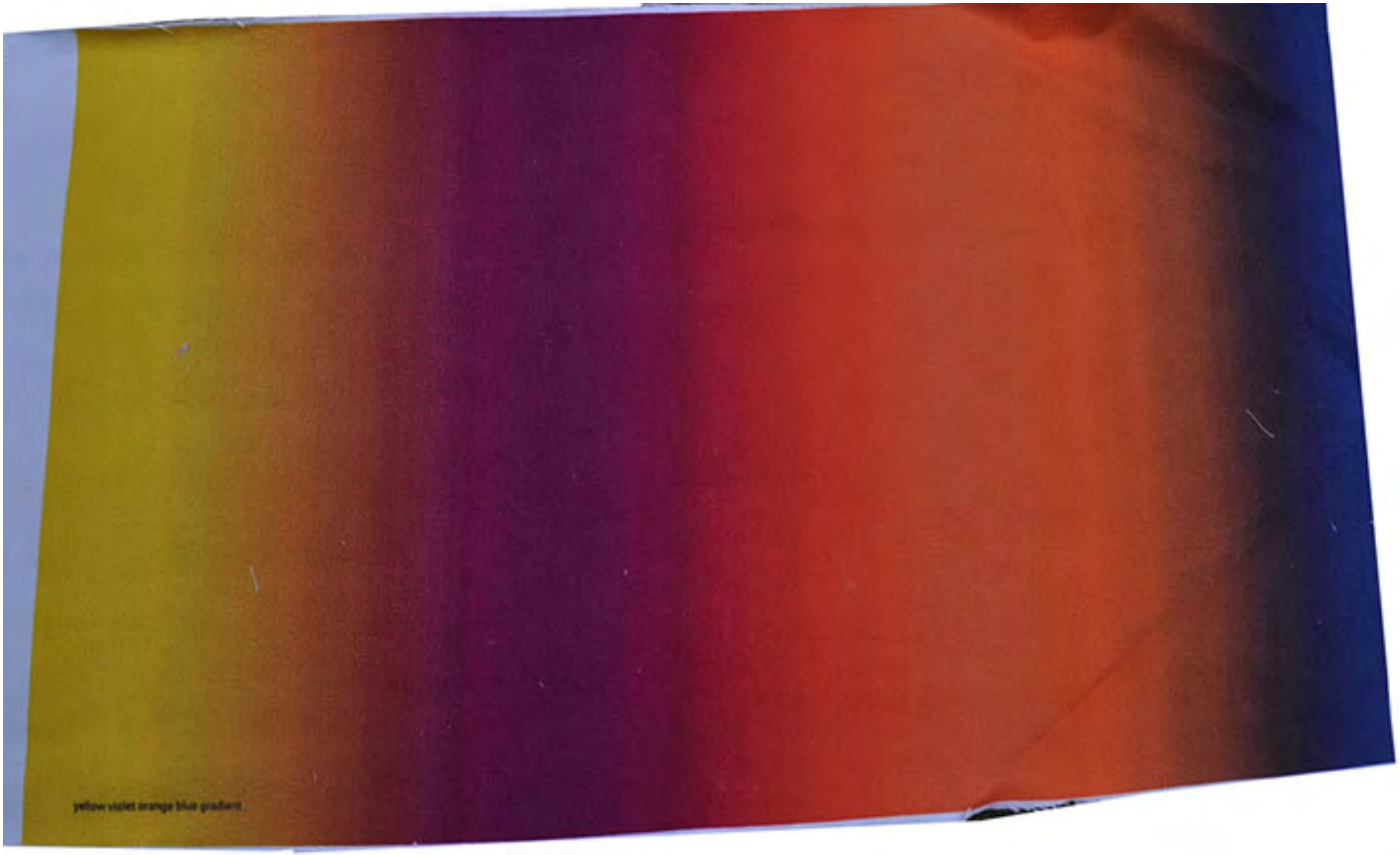
What next

- I am a bit worried that I am repeating the work that Carinna did for her PhD with multiple pass printing, although this is obviously a different medium (textiles rather than paper)
- Whilst I can see improvements in colour aesthetics and greater depth in colour quality and the 3D layering affects are great I am not sure that this technique is a way to get a better colour match between screen to print unless you are perhaps singling out a particular colour, eg black, which over printing would improve.
- There is a danger of over saturation and bleeding with this technique

Gradients

- Several gradient prints created using Adobe Photoshop's gradient tools and printed onto cotton satin
- Gradients are difficult for CMYK printers to replicate both in paper and textile printing because of the way colour is built up in a dithered dot matrix. Issues can include banding
- I was approached by a designer who had been told by a digital print bureau that they would not print one of her designs because it included a gradient effect. I was therefore curious to see how gradients printed and whether issues appeared to be colour dependent

Blue, red, yellow horizontal gradient



Yellow, violet, orange, blue vertical gradient

Dark Blue to dark green diagonal gradient

Natural density gradient over yellow

Black and white horizontal gradient

Observations

- There is some obvious banding between some of the colours but not all.
- The banding is in both vertical and horizontal directions
- Black and white gradient appears pink
- When there isn't such a drastic difference in hue (for example the dark blue to dark green) then the gradient appears without banding. You can also see this in the 'Blue, red, yellow horizontal gradient' between the blue to purple and red to orange whereas there is more banding in the purple to red. Red to yellow and orange to yellow. In the 'Yellow, violet, orange, blue vertical gradient' there is less banding between red to orange the the brown to blue at the end but extreme banding in all the other colour jumps
- The natural density gradient has less banding but the darker areas look pinker
- None of the gradients are particularly smooth

What next

- It would be good to have some advice on the tool kit about gradients as this is a digital tool so might be employed by designers intending to use digital textile printing as their output method
- The black white gradient is a good example of how CMYK printers replicate grey and how it can go wrong with additional magenta dots
- These would be good to look at under the microscope
- It is worth noting that paper prints also struggle with gradients and this is not an issue for textile prints alone

Appendix E
Documentation of Project Tool-kit

This appendix presents photographs of the Project-Toolkit
The website is digitaltextilecolour.org

The website is in development and has completed Stage One where the website structure has been built and populated.

Stage Two will comprise of adding downloads, tutorials, completing variables pages (a detailed outline of each variable listed on the variables page), enhancing the Colour Archive section including Colour Theory, Problematic Colours, and enhancing the Research section including How to Work with a DPB.

Stage Three will comprise of further user testing and adding user generated content.

The set of images shown are screen shots of the website from 3rd February 2022 – date of thesis submission.

Digital Textile Colour

a research tool-kit

Digital Textile Colour

a research tool-kit

About Us

Digital Textile Colour is a tool-kit and information point for designers, artists, makers and SMEs who are looking to understand more about the factors that affect colour outcome in digital textile printing but do not have access to expensive technical equipment and specialist software.

Using this site will help you gain knowledge about how colour is converted from what you see on the screen to the fabric print, and improve your colour intuition.

The information provided on this site is a result of investigations undertaken as part of a Doctoral Research Project by Becky Gooby at the Centre for Fine Print Research, UWE Bristol. The work is part of the 3D3 Research Centre for Doctoral Training, funded by the Arts and Humanities Research Council.

The research work from this project has been conducted using a Practice as Research methodology, where knowledge is aquired through doing and developed upon critical reflection. Textile design, and working with cloth, is naturally a tangible experience and so research undertaken in this field requires visual and tactile signposting. The inquiry therefore was representational of stuiod practice but used to study concepts from a broad range of disciplines including physics, chemistry, physiology, psychology, computer science and art and design. The thinking-doing approach has been informed by Professor Robin Nelson's understanding of Practice as Research and follows the know-how, know-that and know-what model of practice that he has established.

Personal Journey

"This research project arose from personal experience. My expertise and experience are as a freelance, computer-aided-design, printed textile designer. Since first engaging with DTP in 2008 I have seen the industry develop in the UK. My experience of colour matching and consistency issues have been confusing and frustrating, primarily because the process is outsourced and because I was unware of the numerous variables. My background is in Fine Art, block printing onto fabric which became soft sculptural installations but shifted to textile design after undertaking a Masters in Design to refocus my career. I explore digital print as a medium using a mix of hand drawn and computer graphic techniques. The substrates I chose to print upon were determined by the end use or cost. Prints made on cotton had issues with warmer tones such as reds and oranges which were more vibrant than expected, yet greys and darker colours were bluer or duller. Prints on silk appeared too sharp, colours were acidic and highly saturated. Prints on linen were dull and muted, with colour shifts towards magenta. For example, dark grey printed as pale blue and primary hues appeared as pastels. My print bureau were not forthcoming and didn't provide advice about colour matching. I felt ignorant and at fault and wasn't sure what to ask. Working in APCC I made adjustments to designs using vibrance and saturation tools, annotating designs and making samples where possible get the best aesthetic match. Conversations with other designers revealed that this was a wider issue and that many were frustrated by colour results and lack of knowledge to how to resolve. This Doctoral Project seeks to provide answers and support for designers like myself working in digital print."

Becky Gooby

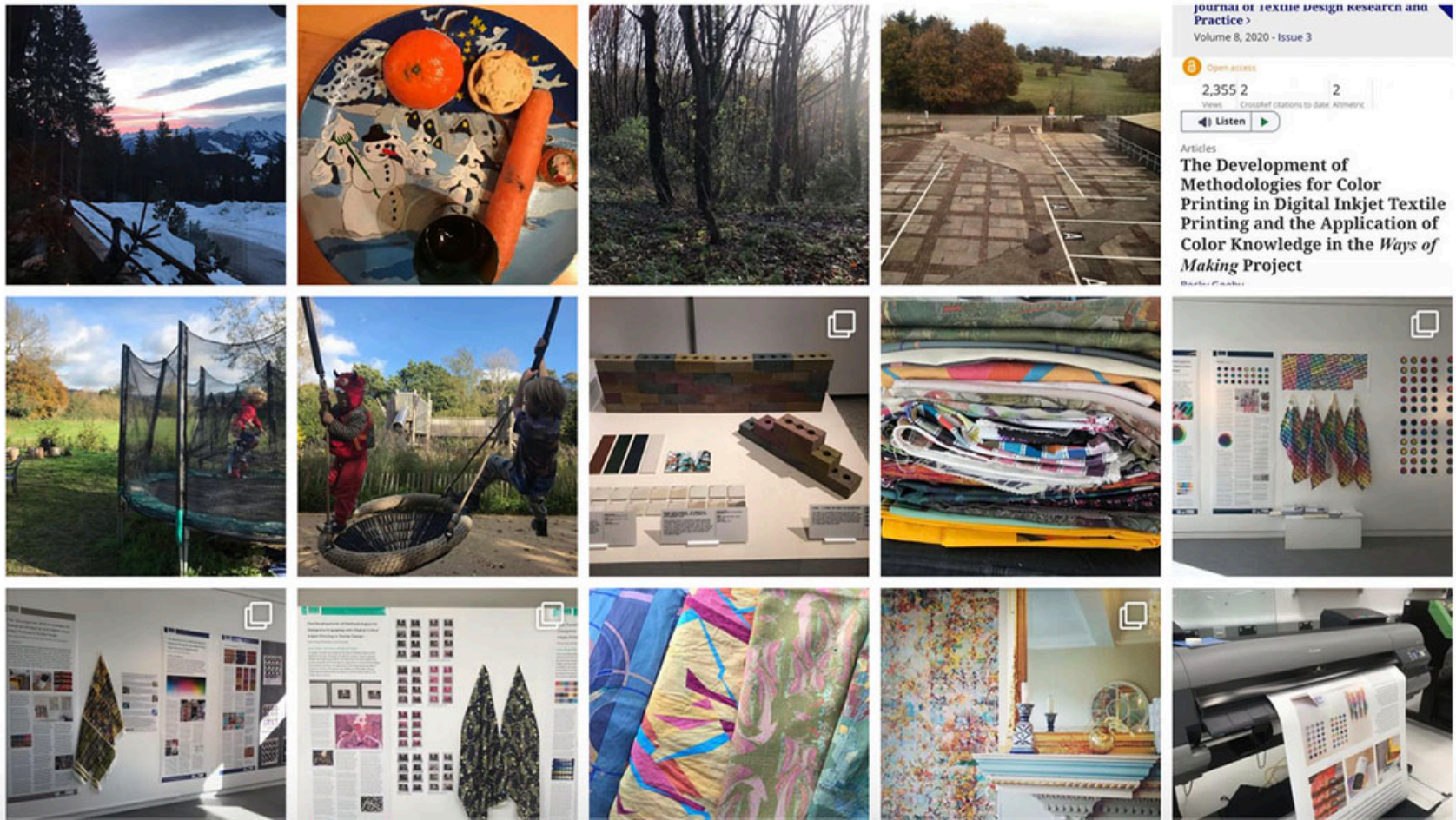
About the Researcher

Becky Gooby

3D3 Doctoral Research Student

Becky Gooby is a printed-textile designer, upholsterer, enthusiastic cyclist, researcher of digital textile printing and mother to two small humans.

beckygooby



About Digital Textile Printing

Photograph of examples of digital textile prints a the Durst stand FESPA 2017

Photograph of Richard Quinn fabric being printed at Epson stand 2017

Digital textile printing (DTP) allows design work to be printed directly from your computer onto fabric. Designs may include photographic images, intricate detail, fine lines and a range of colours and tone. Unlike traditional screen or rotary textile printing, designers are not restricted to a repeat pattern or the need to consider colour separation layers.

Being able to print artwork onto fabric offers unprecedented opportunity for designers to offer bespoke and customised designs. You can become more entreprenuerial and set up your own business without having to have your own printing facilities or become proficient at screen or block printing. You can print a metre or hundreds of metres at the click of a button.

Customers can place an order and you can send it to print, meaning you don't have to hold stock or second guess what might be popular.

Whilst one day we may have our own home textile printers, DTP is usually carried out by a Digital Print Bureau (DPB). You send them your artwork and they print it on the fabric of your choice, ready for you to collect or receive by post. Some bureaus also offer a sewing service or print direct to products.

In this section you can find

Basic Information about Digital Textile Printing

A timeline of the evolution of this technology

Digital Textile Printing environment and sustainability credentials

What Digital Textile Printing can be used for

The colour problem

Digital screen colour, a mix of red, green and blue (RGB) light has a broader colour range to printed colour, primarily a mix of cyan, magenta yellow and black (CMYK) pigment primaries. Whilst there are overlaps between the two colour spaces there are many colours possible in one but not the other, thus out of gamut. A gamut represents the boundaries of the range of colours a device can reproduce. These are determined by the colourants and tonal information ie the darkest producible black and the brightest white.

The research project behind this tool kit was set up to consider how designers can achieve accurate colour results when digitally printing on a range of fabrics. The aim to establish a best practice guide for designers wishing to obtain a more acceptable print-colour match. The guide is presented here as an online tool-kit to support colour knowledge in digital textile printing, increasing their ability to resolve colour issues during design stages.

Digital Textile Colour

a research tool-kit

Basic Information

Photograph of Mimaki Digital Ink-Jet Textile Printer in action – with insert of the print cartridges at the back

The development of digital printing is a major change within the textile design process because it allows designers to print directly from their computer onto fabric. A user may choose from a variety of image-editing software and print via ink-jet or dye sublimation processes onto numerous fabrics. The colorant, dyes or inks, is applied to the cloth surface to build up a perceived, full-colour image from a mixture of cyan, magenta, yellow and black. Secondary processes, such as washing and steaming or heat press, allow fixation and in the case of dyes, further permiate the fibres.

However there are concerns about colour consistency and outcome. For example, there is a marked difference between the screen-colour and print-colour. Software allows users to select colours unprintable using CMYK (cyan, magenta, yellow and black) colorants. Screen colour is made up of red, green and blue light and so the range of colours produced is different from the colours from CMYK. The range of printing machines and the methods that they use to apply, and represent colour, is considerable which might obstruct understanding.

A textile designer will be required to experiment with a number of variables in order to feel colour confident which may be time consuming, costly and imprecise.

In this section you can find

Substrates: What can I print on?

Printing Methods

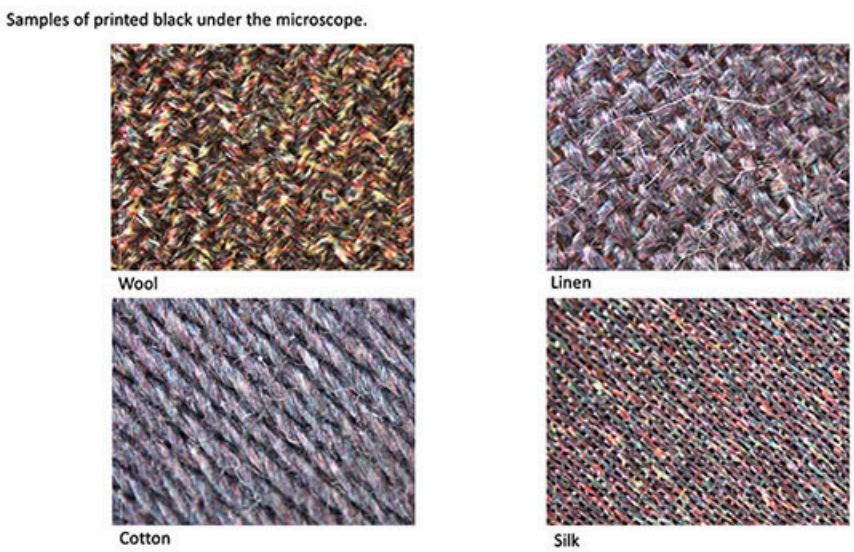
Colorants: What dyes and inks are used?

Uses: What kind of products can be produced?

Production: Digital Print Bureaus – What are they and how to work with them?

Substrates

by **admin@digitaltextilecolour.org** – 10/02/2021



Photographs of a set of black swatches printed on different fabrics – seen under a microscope

Your fabric choice will ultimately be determined by the end product but as different fibres react differently to the printing dyes and inks. the choice of fabric will really impact the final colours in the print.

When choosing a fabric to print upon you will need to consider the construction, yarn and weave of the fabric because all of these things will affect the achievable colour range. Cotton, polyester and hybrid fabrics are the most common fabrics in digital textile printing but silk, wool and linen can all be used. Each will have its own absorbency, surface tension and potential for wicking (moisture absorption) which will affect the optimum amount of dye or ink that can be used.

Protein fibres, made by animals, such as wool and silk, have good absorbency and colorant retention, as do cotton and bamboo, cellulose fibres. Other cellulose fibres such as linen and hemp which are oilier, have less absorbency and prints tend to look washed out or faded. Synthetic fibres, which are man-made, have poor to little absorbency and so colorant sits on the surface, reducing rub fastness.

Colorants

by admin@digitaltextilecolour.org – 10/02/2021

Photograph of different coloured reactive dyes in pots

Digital textile prints can be made with dyes or pigment inks. Dyes are organic compound molecules dissolved in water or an organic solvent, and inks (pigments) are non-organic particles in a suspension. .

Dyes have a superior colour range whilst pigments produce more permanent colour and do not require additional processing. For example, steaming and washing for fixation. Pigments are more likely to suffer metamerism issues, where the colour can appear different under different conditions, which creates quality issues particularly for retailers using bright shop lighting. It is not clear how this will be resolved with the industry drive towards the use of pigment inks in digital textile printing.

Dyes are soluble and more suitable to ink-jet printing because they have a low viscosity and can pass through the print head. Pigments can be ground small enough to be used in ink-jet printing but frequently clog print heads with small particles. Textile colorants are water-based and are mixed with a binder. The purity of colorants is determined by cost, stability and multiple end-use requisites meaning quality may be compromised impacting colour outcome

At present there are four types of colorant used in digital textile printing; reactive, disperse, acid and pigment. The type is dependent on the substrate and the printer. Acid offers deeper, brighter shades but is restricted to silk, wool and nylon. Reactive reacts well to washing and light, produces bright shades but is limited to natural fabrics. Disperse is used with polyester but can be used in thermal dye-sublimation printing. Pigment is used with any substrate and has good washability and lightfastness, but causes printer issues. Additionally, the colour gamut is small and shades are dull.

Repeating batch quality and colour consistency is a challenge due to manufacturing methods and material sourcing. Furthermore, dyes and pigments have limited shelf life. Colour stability is therefore not guaranteed. A colorant's viscosity and consistency is key to managing colour outcome.

About Digital Textile Printing • Basic Information

Printer types

by **admin@digitaltextilecolour.org** – 10/02/2021

Inkjet printing jets out dots of dye or pigment ink, onto the fabric as it passes under an array of print heads. The dots of dye are placed in a particular pattern, known as a matrix, and are so tiny you can only see them under a microscope. When the pattern of dots is built up it is perceived as solid colour. The dots need to be the same size and shape to create this illusion which can be tricky to achieve when they are landing on a textured surface like fabric. This technique was invented originally for paper printing which is a smooth non woven surface and has been adapted for textile printing. Because there isn't any heat involved a wide range of fabrics can be printed upon and in theory, as long as the fabric can fit under the print heads, a range of textures as well. However print heads can get clogged by fluff from fibres so some thicker or fluffier fabrics can be problematic. Silky or slippery fabrics can also be difficult to print on if they wrinkle as they pass under the print heads. Some more sophisticated printers have ways of holding the fabric tight as it feeds through to overcome this but not all so ask your bureau lots of questions when you make your fabric choice.

Dye Sublimation uses heat and electro-activity to transfer the sublimation ink, also known as disperse dye, to the fabric. The ink starts as a solid and is heated until it becomes a gas, this is the sublimation part. The gas particles are then transferred to the substrate using electro-activity, where they cool and solidify. The substrate will either be a fabric, which is known as direct dye sublimation, or a transfer paper, known as in-direct. In-direct dye sublimation applies the design from the transfer paper to fabric using a heat press. Only synthetic fabrics, polyesters or poly-mixes, can be used because of the heat required which could burn or singe non-synthetics.

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Substrates

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Colorants

About Digital Textile Printing • Basic Information

Digital Print Bureaus

by **admin@digitaltextilecolour.org** – 11/02/2021

Digital Print Bureaus offer a production service to designers and SMEs. They are primarily located in urban environments speeding up textile production to retailer.

There are international, commercial bureaus such as Spoonflower and Contrado as well as smaller independent businesses. A survey of Digital Print Bureaus in the UK revealed several established companies (Glasgow CAT, Silk Bureau, Fab Print) but that it is a tricky business model with many companies closing (Cameron Gilmartin BeFab, Surface Pattern Print). Some have specialised in a particular field to retain viability (Silk Bureau, Hartleys).

The designer is remote from the process and prints are made in their absence. Commissions may even be conducted entirely online with fabric delivered negating any need for contact. Designers need to learn how to communicate with a DPB and need practical support from the DPB on how to prepare artwork, what colour management processes they use and information about their print environment to ensure a satisfactory outcome and avoid re-printing.

You can read more about the rise of Digital Print Bureaus in an article by Debbie McKeegan linked here.

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Printer applications

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Ink Wastage

Environment and Sustainability

Digital textile printing reduces the amount of water use and ink wastage making it a relatively environmentally sustainable process in comparison to other textile printing methods. Digital Print Bureaus are more likely to be located in an urban environment, local to their customers which reduces transport costs and occupy less space than a traditional textile mill or factory. Batch printing and the ability to react quickly to trends allows businesses to carry less stock. This reduces storage costs and the likelihood of stock wastage as fabric can be printed to demand.

In this section you can find out more about

Dye and Ink usage and wastage

Water usage and wastage

Pattern cutting wastage

Production location and shipping

About Digital Textile Printing • Environment and Sustainability

Ink Wastage

by **admin@digitaltextilecolour.org** – 11/02/2021

5 litre tub filled with 6 months of reactive dye wastage from the Mimaki TX2-1600 digital inkjet textile printer

Ink Wastage is minimal in digital textile printing making it a comparatively more sustainable and environmental process to other forms of textile printing where lots of excess print paste gets washed away at the end of printing.

Only the ink or dye required will be emitted by the print heads. Whilst some of this will be removed in secondary processes such as washing, drying and steaming this is inconsequential.

About Digital Textile Printing • Environment and Sustainability

Water Usage

by **admin@digitaltextilecolour.org** – 11/02/2021

Water usage is also very low in digital textile printing. Some fabrics will require steaming and washing after printing to fix the colours and remove any excess colorant but there is no need to wash lots of screens or equipment. The colorants themselves will be water-based but other than post-treatments water use is very low making digital textile printing a more sustainable and environmental process than other textile printing methods.

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Ink Wastage

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Pattern Cutting Wastage

About Digital Textile Printing • Environment and Sustainability

Pattern Cutting Wastage

by **admin@digitaltextilecolour.org** – 11/02/2021

Digital textile printing can be used to print direct to patterns. This means that pieces can be placed efficiently on the fabric to minimise pattern cutting waste. Dye-sublimation printing in particular is used for this, especially for sportswear, because there are fewer issues with fabric shrinkage which can happen when a fabric is steamed and washed after ink-jet printing.

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Water Usage

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Location

About Digital Textile Printing • Environment and Sustainability

Location

by **admin@digitaltextilecolour.org** – 11/02/2021

Digital print bureaus tend to be loated in urban environments, occupying much less space than a factory or textile mill. Often they are local to their customers meaning that manufacture can be conducted in the same country that the products are to be sold in. This reduces transport costs and the impact of shipping on the environment.

Many countries are investing in digital manufacturing to enable more local production. However overseas production continues with the largest proportion of digital textile printing conducted in China as many prints can be ordered online and remotely.

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Pattern Cutting Wastage

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Bespoke & Customisation

Uses

Digital print allows designers to use greater creativity, using fine lines, tone, photographic imagery and digital effects. Colour use is not restricted to the number of print layers. Imagery is not restricted by repeat or screen size. With low set up costs and the ability to print small batches a designer can be free to customise and be innovative. Downtime is minimal as designs can be printed to demand, responding to changes in trends and markets, keeping wastage low. It can be used as the basis of futher textile work such as embellishments. It can reduce pattern wastage by printing direct to pattern outlines although allowances have to be made for shrinkage.

Digital textile printing has been used in costume design to print the illusion of heavy cloths such as tweed or wool onto light weight, flexible fabrics allowing freedom of movement for the performer. Simlarly trompe d'oil effects have been used to print images of jewellery, sequins or embroidery onto fabrics used in fashion and soft furnishings.

As with all new technologies the design language is evolving and time is required to develop it from mirroring techniques and photoshop filters. The speed at which the technology has developed has hindered designers' ability to embed and hone their skills meaning that for many the constraints of the technology, and it being an outsourced process, has governed their creativity rather than enhanving it. It is seen as an instantenous option, achieving quick results. However, this leads to frustration for users lacking experience when print-colour outcomes aren't as expected and they are unaware that time consuming colour sampling and testing is required.

In this section you can find out more about

Examples of use in Interiors

Examples of use in Fashion

Bespoke, Customisation and Personalisation

Entrepreneurial Business Models: Production Methods

About Digital Textile Printing • Uses

Interiors

by **admin@digitaltextilecolour.org** – 11/02/2021

More recently digital textile printing has been used for interior fabrics. Interior fabrics typically are less colourful and undergo fewer trends and fads to fashion fabrics. They also have to undergo rigourous testing to stand up to wear and tear and retain light fastness which can be a challenge for pigment printed textiles. However latex printing and improvements with colour matching to wallpaper prints has seen an increase in digitally printed interior fabrics.

Examples of designers using digital textile printing for interiors include

Timorous Beasties

BlackPop

Boeme Design

Deborah Bowness

You can find further examples of designers using digital textile printing in interior design in Dr Simon Clarke's 'Print Fashion Interiors'

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Problem Colours

About Digital Textile Printing • Uses

Fashion

by **admin@digitaltextilecolour.org** – 11/02/2021

Digital textile printing has been used in fashion to create colourful pattern designs. Prior to digital textile printing the colour in a design would be restricted to the number of stamps (screens, rotary rollers, blocks). Digital textile printing allows digital artwork to be replicated onto fabric meaning that photographic imagary, fine lines, tone and detail can all be incorporated as well as a greater range of colours.

Some of the design vocabulary has been limited to mirroring and photoshop filter techniques but many designers are becoming bolder and cleverer with their artwork.

A few examples of fashion designers exploiting digital textile printing are

Mary Katranzou

Basso and Brooke

Jakob Schlaepfer

Marly van Lipzig

You can find further examples of fashion and digital textile printing in Dr Simon Clarke's 'Print Fashion Interiors'

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Production methods – Just in Time, Concept to

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Interiors

About Digital Textile Printing • Uses

Bespoke & Customisation

by **admin@digitaltextilecolour.org** – 11/02/2021

Digital textile printing enables designers to offer bespoke fabrics and customisation to their customers. Designers can work with customers to create a unique look and as digital artwork can be printed in small batches, incorporating photographic imagery, prints can be made with personal details. Further more fabrics can be embellished after printing.

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Production methods – Just in Time, Concept to Consumer, Web to Print, Drop Shipping

About Digital Textile Printing • Uses

Production methods – Just in Time, Concept to Consumer, Web to Print, Drop Shipping

by **admin@digitaltextilecolour.org** – 11/02/2021

Digital textile printing can be used to meet many modern production methods such as Just in Time, Concept to Consumer, Web to Print and Drop Shipping. These all require quick turn arounds and fast responses to new trends. For example a product might be printed in a small batch to test the market. If it is popular the product can be quickly printed and put into production without the need to hold lots of stock. These production models go hand in hand with online sales.

An example of a company using these production models is RedBubble. They have a bank of images, uploaded by users, and products which customers can select from. When a sale is made RedBubble commission the product to be made and ship it to the customer. The customer receives a unique product that they have chosen the artwork for. The manufacturer is paid for producing the product. The user who uploaded the artwork is paid a percentage and RedBubble receive the rest.

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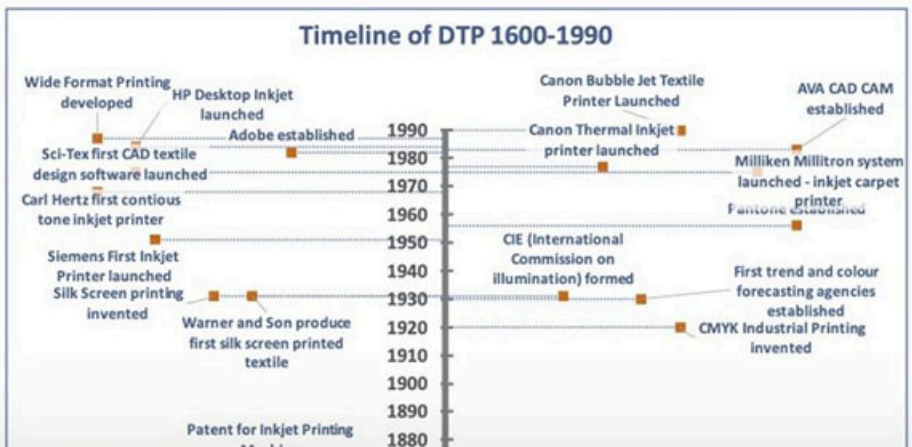
Timeline

Digital printing for textiles is a relatively emerging technology despite being in use since the 1970s in carpet printing. However the first recognisable digital textile printer was produced in 1991 by Stork. The Stork TruColour TCP2500 was designed for sampling and was superseded by the Fashion Jet Textile printer in 1995 for small print runs known as strike offs. Mimaki brought out their first TX series in 1998. It wasn't until 2003, at trade show ITMA held in Birmingham, that digital textile printing seemed to become an established technology with the exhibition of machines by Du Pont, Mimaki and Reggiani. Many specialist textile printer companies have since been bought up by larger reprographic printing companies establishing digital textile printing as of viable economic interest. For example Epson recently bought Robustelli and EFI bought Regianni.

China is the biggest producer of digitally printed textiles with 15% of production in 2016. Prior to the technology taking off in China, Como in Italy was the leader and retains many specialist companies. Digital textile printing accounts for between 3-5.5% of all printed textiles and is primarily used for clothing and display (signage and flags) but increasingly household and technical textiles. Both Western Europe and Asia are growth markets for production due to urban production and low costs. In the UK government grants have promoted a return to inhouse printing and rapid prototyping enhancing the UK digital textile printing industry.

The industry has been driven by Just-in-Time and Concept-to-Consumer production methods as well as social media trends. This has attracted entrepreneurial business models. For example drop shipping where items are made only once the order has been placed, reducing the need for stock to be held.

The timeline below provides an overview to the evolution of this technology.



Digital Textile Colour

a research tool-kit

Research

This tool-kit is the outcome of a Doctoral Research Project. Part of the project involved testing variables and developing methods to support designers colour knowledge. As well as practical experiments a number of industry experts were interviewed to provide case studies of how practitioners are engaging with digital textile printing.

In this section you can find

Experimental: Variable Testing

Methods: Three methods developed by the research project to support designer's colour knowledge and a number of resources

Colour Conversations: A series of interviews with industry experts

Experimental

Practical experiments in this project have focused on testing different variables to determine their impact. The experiments have considered the effect of pre-coatings, coloured substrates, steaming post treatments, multiple print passes, colour profiling and altering colour management processes.

The findings of the work determined that

- There are numerous variables that impact colour outcome within the digital textile printing environment. Many of which are out of the designer's control especially when production is outsourced
- Some of these variables can be exploited by the designer for creative potential
- Colour Management and Textile Chemistry have been adapted for digital textile printing and this adaption comes with compromises
- Design Education needs to include the impact of these variables in order to provide designers with the ability to ask knowledgable questions of Digital Print Bureaus and make informed choices about their print environment and end-product

In this section you can find details about experiments that investigated

Profiling

Altering Colour Management processes

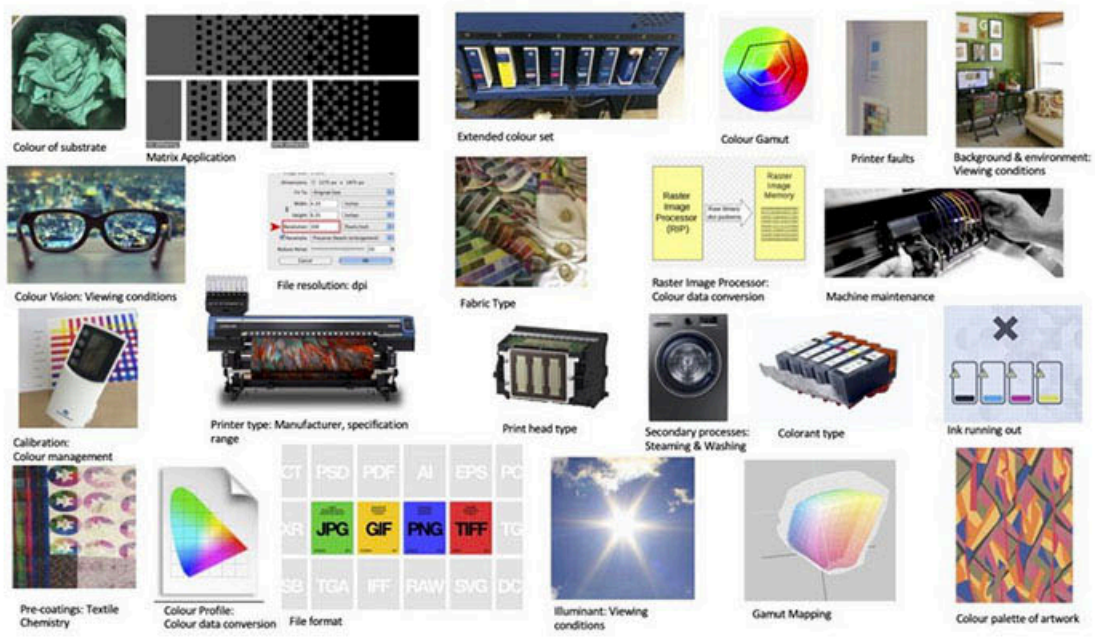
Multi-Pass prints

Fabric Pre-coatings

Steaming

These experiments explored several of the variables that impact colour to determine their impact on colour results. Profiles were shown to have subtle but clear colour differences when assigned to artwork. Whilst there are no current virtual device profiles specific for digital textile printing, designers should understand their purpose and consider which profile is appropriate for the print environment they will use. The research concludes that darker colours are perceived as richer when printed in several passes and that fugitive colours created by overlapping print passes offer artistic potential but would be challenging to produce economically viable or consistent prints suitable for the textile industry.

Variables



There are numerous variables that affect colour fidelity in digital textile printing. Many of these are out of the designer's control and difficult to predict. Some are distinct to digital textile printing such as the structure and composition of the fabric substrates, the fabric pre-coating and the secondary processes. Others are problems shared with the reprographics and photographic industry. You may be required to experiment with a number of variables in order to feel colour confident.

A number of practical investigations modifying the key variables were conducted and feature in the Experimental section of this website. The impact of colour management, pre-coatings, secondary processes and print passes on colour outcome were all explored.

A poster was produced at the start of the project mapped out many of the variables that affect the colour outcome.

Methods

Three methods were developed by the research project to aid a designer's colour expectation knowledge in Digital Textile Printing. These visual prompts are intended to support designers to build their own internal color look-up table, enhancing their digital print-color knowledge, enabling them to predict and resolve color issues during the design process.

In this section you can find

Method One: Colour Reference Book

Method Two: Digital Lab Dip Tests and Colour Maps

Method Three: Indicator ICC Profiles

Further Resources: Downloadable test files, Reading List, Glossary, How to work with a DPB

Existing Colour Tools and Support

There are a wide range of colour tools, including websites, apps and equipment which purport to support colour fidelity and conversion. It can be tricky to ascertain which are useful or appropriate for aiding screen to print colour conversion in DTP, and many are costly. Most designers will be familiar with colour reference systems such as Pantone, where you can select, identify and communicate colour using swatches and accompanying data. Pantone have numerous products, some digital, some physical, as well as apps and software aimed specifically at the fashion and textiles market but they are costly. Design software producers, Adobe offer Adobe Colour, a free colour website with examples of colour harmonies as well as colour data which support creatives working with their software. Similarly they have colour apps and provide colour useful colour data and access to colour libraries like Pantone in their software via the colour picker tool.

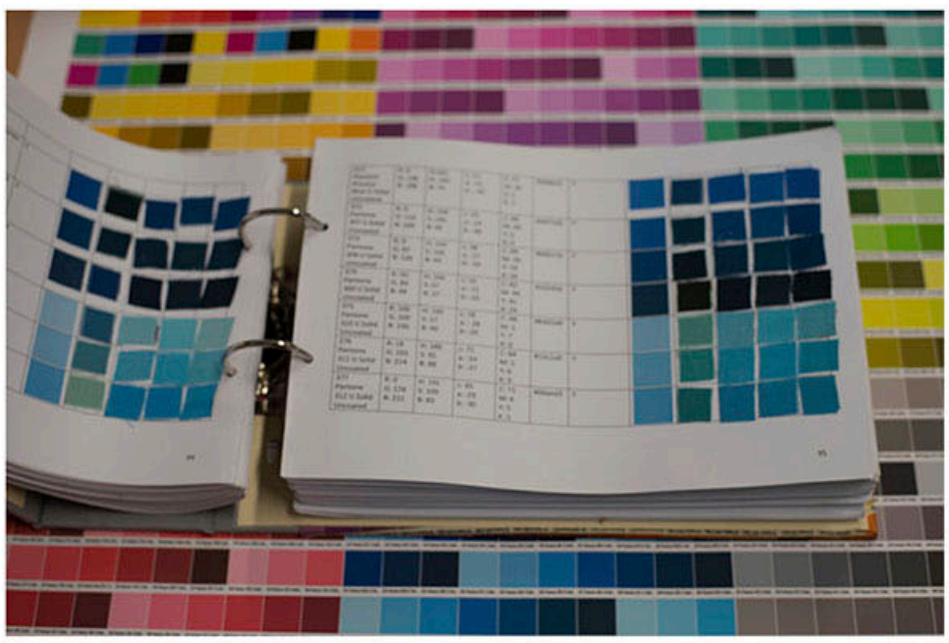
Basic screen calibration has become automated across most operating systems and computer models making it difficult to do more than adjust the brightness of your screen or set the screen profile. Apple's new True Tone technology allows the latest macs to detect changes in the environment to adjust the screen colour automatically.

The usefulness of colour management equipment and colour subscription services will depend on the level and type of design work being carried out. For example a freelance designer may only need access to subscription services to gain colour information whereas. a textile studio may need to purchase a simple colour management set up with calibration and measurement tools as well as a digital and physical colour swatches. Additionally there are many simple things that designers do such as creating a Granger Rainbow, a gradient tool which creates an image demonstrating the full range of colours a screen can produce for easy comparison. Furthermore keeping accurate records when assessing samples and checking colour matches whilst ensuring that the environment is as consistent as possible (same illuminant, time of day, neutral clothing) promotes best practice. A table of simple suggestions for colour tools is outlined below which demonstrates that freelancers can access lots of colour information and data for free or for minimal cost and shouldn't need to spend much money on colour tools.

Methods • Research

Colour Reference Book

by **admin@digitaltextilecolour.org** – 11/02/2021



Photograph of an open page of the Colour Reference Book

To evidence that there is a difference between screen-colour and print-colour, and further variations between substrates, a colour chart was created, using the 1137 colours in the Pantone© solid uncoated colour library in Adobe Photoshop Creative Cloud (APCC). The chart was printed onto four different substrates (wool, linen, cotton and silk) using a digital textile inkjet Mimaki TX2-1600 printer, with reactive dyes (Cyan, Magenta, Yellow, Black, Light Cyan, Light Magenta, Red and Blue).

These fabric swatches were compiled into a colour reference book displayed here alongside full cloth prints of the Pantone range with a paper print as a comparison. Each swatch has the corresponding numerical values (RGB, CMYK, HSB, Hex and LAB) and a paper print, as the closest visual match to the screen-colour. The book provides a broad range of colours and data for comparison. The differences between screen-colour and printed colour, as well as between substrates, are evident. This is particularly clear in neutral ranges such as greys, blacks and browns, and colours from the blue and magenta tonal ranges. Several swatches were enlarged and reprinted after initial visual assessment to observe colour differences on a larger scale. These are displayed alongside a paper print for comparison.

Artwork of the full set of swatches from the Pantone LIbrary

Initial analysis revealed that 227 of the 1137 colours were considered out of the printable gamut of a generic CMYK printer. This was determined by APCC's out of gamut warning in the colour picker tool. The majority were from the magenta tonal range (53 purple and 38 pink), whilst 46 were classified by the researcher as green, 27 red, 21 blue, 20 yellow, 20 orange and 2 brown. Some colours which were flagged as unprintable, had a better than expected colour match. For example, shades of warm reds and oranges were flagged, yet are a close visual match to the screen colour. Swatches of neutral greys differ greatly from screen colour but were not flagged. This discovery highlights how colour tools may cause further confusion about colour results.

Photograph from Exhibition of Practice -display showing the Colour Reference Book (on plinth) and prints on different fabrics (hung on wall)

Data analysis established that a hue with a high red RGB value, 229 and above, would be likely to be out of gamut for a generic CMYK printer. Colours with a hue HSB value between 252 degrees and 288 degrees, the blue to magenta range, were also likely to be considered out of gamut. Likewise, bright colours, with a brightness HSB value of 80% and higher, would be likely to be considered out of gamut.

The research envisages that the Colour Reference Book, as part of an online colour toolkit, could be used to look up hues in order to get a sense of how they might print upon different substrates. Currently Pantone offer colour system swatches printed onto Cotton, Nylon and Polyester but not Silk, Wool or Linen and the swatches are dyed rather than printed. Several DPBs such as Spoonflower have colour charts that you can pay to print on your choice of substrate with corresponding digital colour data. Spoonflower allows users to upload designs which customers can select for printing. A search of these user designs show several colour charts recommended as designer reference tools. These have positive reviews supporting the idea that this form of colour tool is helpful and aids colour expectation and assurance.

The research envisages that the Colour Reference Book, as part of an online colour toolkit, could be used to look up hues in order to get a sense of how they might print upon different substrates. Currently Pantone offer colour system swatches printed onto Cotton, Nylon and Polyester but not Silk, Wool or Linen and the swatches are dyed rather than printed. Several DPBs such as Spoonflower have colour charts that you can pay to print on your choice of substrate with corresponding digital colour data. Spoonflower allows users to upload designs which customers can select for printing. A search of these user designs show several colour charts recommended as designer reference tools. These have positive reviews supporting the idea that this form of colour tool is helpful and aids colour expectation and assurance.

Example of pages from Colour Reference book

Photograph of example pages from Colour Reference Book

The Colour Reference Book demonstrates that achromatic colours and hues with a high magenta or blue tone are problematic and will require careful colour testing. Therefore, designers may wish to consider how they use these colours within a design. A full download of the Colour Reference Book will be available soon.

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Microscope Images

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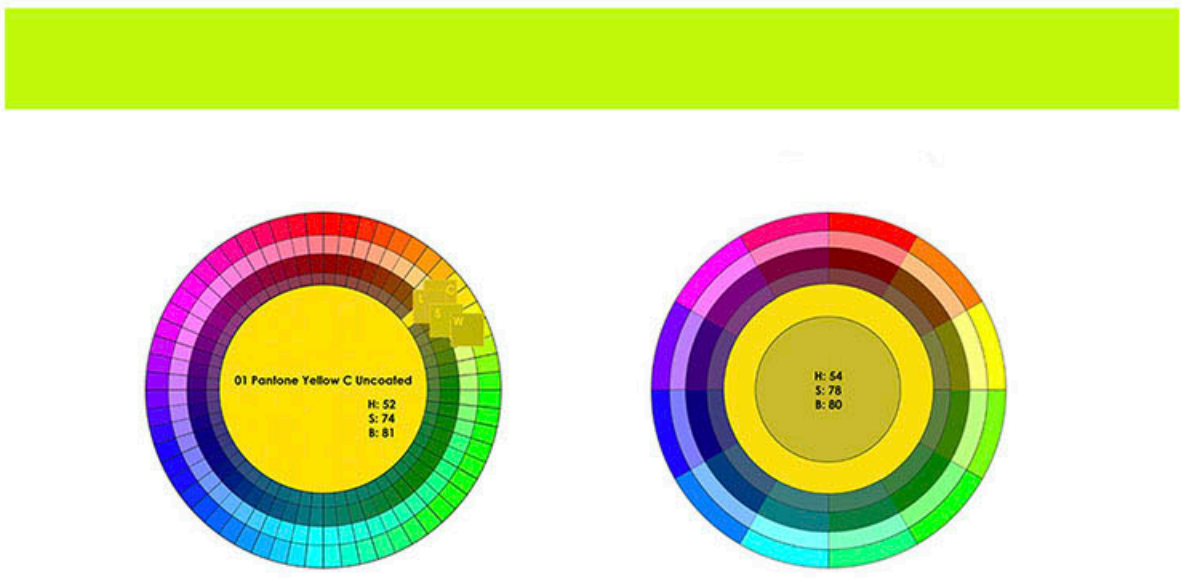
Colour Maps

Methods • Research

Colour Maps

by **admin@digitaltextilecolour.org** – 11/02/2021



Example of at set of Colour Maps – Map One (left) shows the screen colour centre and the digitised swatches on the edge of the circle in comparison. Map Two (right) shows the screen colour and an indicator colour (inner circle) to show the expected colour change between screen to print. The indicator colour is derived from average hue, saturation and brightness shifts after measuring the swatches.

Colour Maps A series of indicator colour maps were produced using mean averages of hue, saturation and brightness (HSB) value shifts for a set of colours. These colour maps are presented here as A1 paper prints. Digitised swatches were plotted onto the colour maps to visualise printed colour changes from the screen colour. The digitised swatches symbolise a digital lab dip test and illustrate how a colour might shift when printed onto different substrates. A lab dip is the term for a fabric sample used by the manufacturer to establish a colour match with the buyer's supplied swatch or colour standards. The maps offer visual prompts to allow designers to build their own internal colour look up table, enhancing their digital print colour knowledge and enabling them to predict and resolve colour issues during the design process.

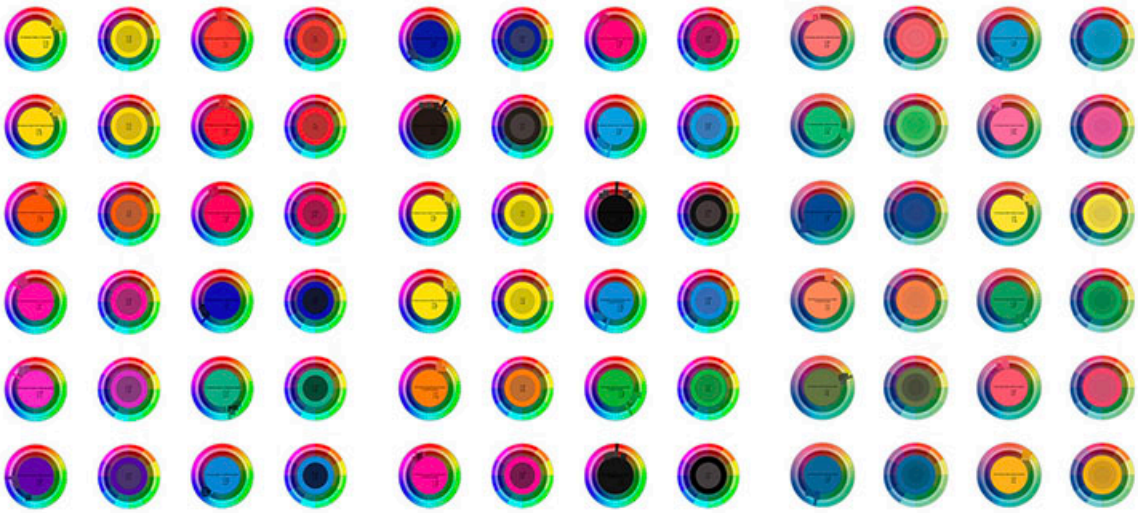
The data was obtained through measuring two sets of printed swatches in the colour reference book. Set one consists of prints from the first 24 Pantone© colours to represent a comprehensive range of highly saturated, spectral hues (red to purple). Set two is composed of colours from a colour rendition chart. Rendition charts are made up of key test colours such as RGB and CMYK primaries, a greyscale and colours found in nature, for example sky blue.

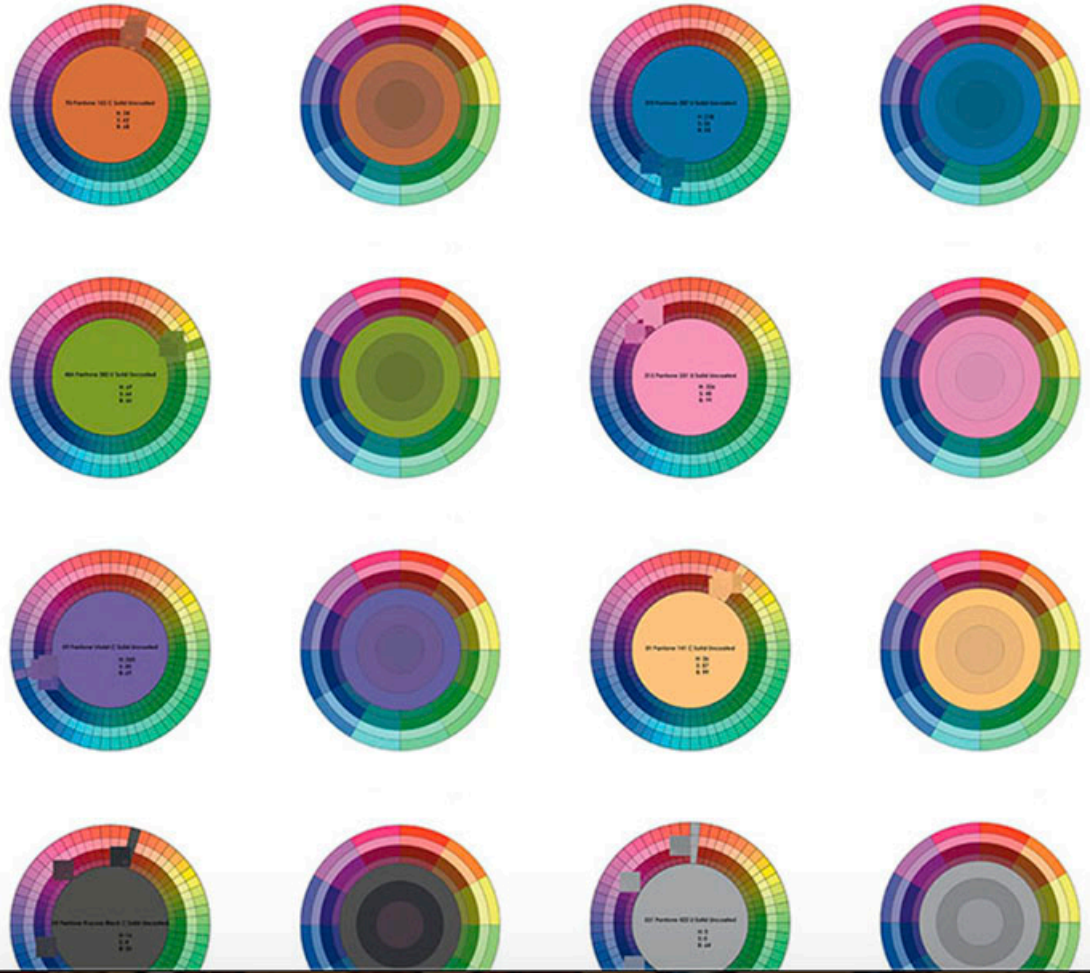
Set Two – the set of swatches which were used for measuring

The swatches were measured using a Kodak-Minolta FD-7 spectrodensitometer which returns sophisticated colour measurements using filters to measure the wavelengths reflected from the colour sample. The spectrodensitometer was set up to measure the reflectance value under D65 illuminant conditions, the standard for measuring textiles, and return CIE LAB, the mathematical model of human vision, and wavelength (nm) values from 380-730nm. The LAB coordinates were entered into the colour picker tool in APCC to display a digitised version of the printed swatch, representing a digital lab dip test.

Finally, the corresponding HSB value was recorded so that the numerical data could be compared. The use of the HSB colour model allowed simpler average comparisons to be made which were more of a challenge to calculate using the LAB model. Each map is a 360-degree hue colour circle that has inner rings decreasing in saturation and brightness. The digitised swatches show the clear reduction in saturation and brightness to be expected when printing on to fabric and some discernible differences in hue.

A complementary map representing an overall colour expectation shift was also produced. An average HSB value was taken using the measurements of all substrates for Set One, and the resulting colour and values placed at the circle's centre, encompassed by the screen colour. Set Two has two overall colour shift expectations, centre circle and encompassing circle, using median data from two data sets, one which includes wild card values and one without. These secondary maps offer an immediate idea of expected colour changes to designers by juxtaposing the screen colour with an average, anticipated print colour.





The maps reveal that detailed colour testing and adjustments will be required to obtain satisfactory colour matches, particularly for prints on Wool, Silk and Linen. Blacks, magenta tones and cooler blues and greens demonstrated the greatest hue shifts and changes to saturation and brightness, supporting analysis from the Colour Reference book.

These diagrams demonstrate the gamut mapping process by visualising the shift from the input colour range on screen, to that of the printed output colour space. Gamut mapping is the recalculation of hue values to transition from one colour space to another. Converting pixels of light on screen to printed dots of colour involves considerable colour modifications. The methods applied are known as rendering intents. A rendering intent will prioritise certain colour qualities over others, depending on the desired image outcome. They have been developed for enhancing prints on paper and subsequently do not account for textile substrates. A specific rendering intent has not been developed for printing onto textiles. It is likely that a designer will not even be aware of the rendering intent used by the DPB nor their purpose and impact on colour outcome. The fabric prints tested as part of this research used a perceptual rendering intent which is the standard gamut mapping method used in UWE's Digital Print Bureau.

Photographs of exhibition of the Colour Maps at Data Ache Conference in Plymouth 2017

The research findings from these investigations determine that the substrate has a great impact upon colour outcome. Visual analysis of all four substrates compiled in the Colour Reference Book demonstrates poor colour fidelity for neutral and achromatic colours (browns, blacks, pastels and greys) and that there are further issues with colours with a magenta or blue undertone. In general, the digital lab dip tests demonstrate differences in saturation and brightness from screen to print. On average printed colour decreases between 10-20% and shifts clockwise around the hue circle from 2-25 degrees. These differences are visualised as colour maps which support designers' colour expectation knowledge in order that they might confidently gauge printed colour results.

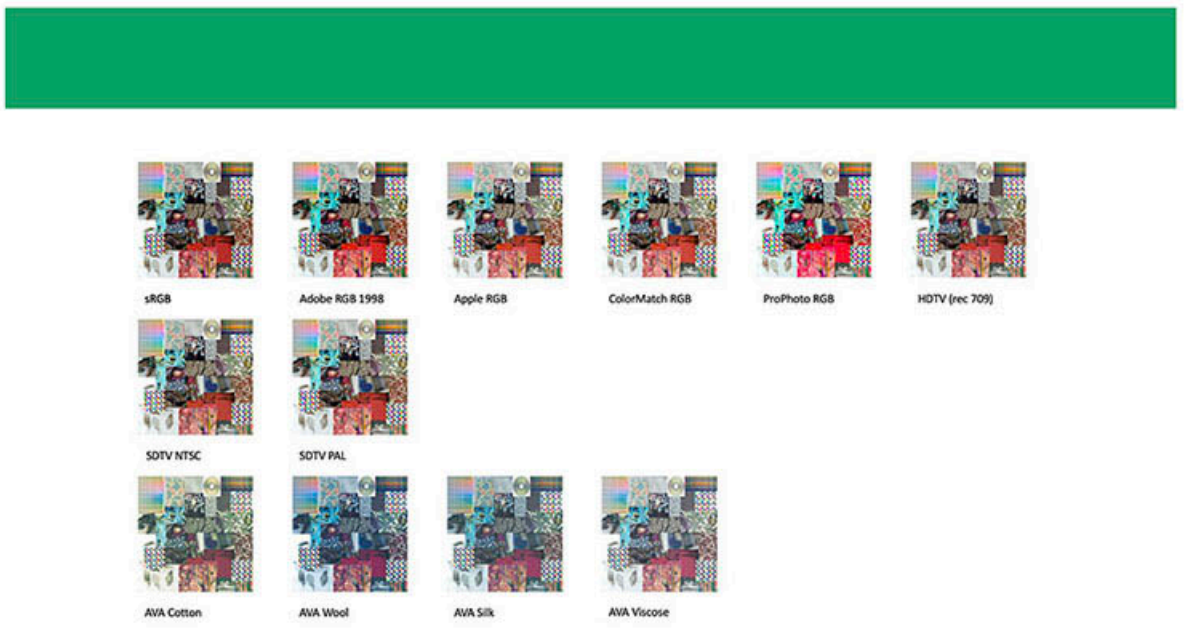
Digital Textile Colour

a research tool-kit

Experimental • Methods

Indicator Colour Profiles

by **admin@digitaltextilecolour.org** – 11/02/2021



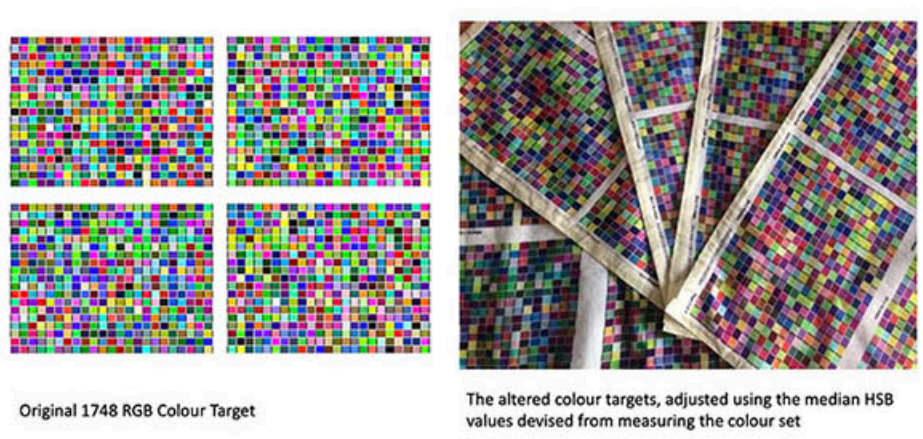
Images of different icc profiles applied to a Colour Collage

A set of prints were made to observe the changes to the overall appearance of an image by assigning different virtual device profiles to a specifically created colour test collage. Consequently, the research considered whether a profile could be created which indicated to the viewer the colour alterations to expect when printing onto different textile substrates.

These profiles were developed using the existing data from measuring the Colour Reference book. The aim was to provide an indication of expected colour changes to a designer viewing their image on a computer display, allowing them to make adjustments to obtain a better colour relationships and balance prior to printing. The profiles are represented here as an A1 paper print.

Profiling is a means of comparing measured reflectance data, from RGB (red, green and blue) or CMYK colour ranges, produced by a particular device or devices, with known reflectance data from International Colour Commission (CIE) models. ICC profiles were developed by the International Colour Commission (CIE) in 1993 as an open profile format which could be used universally across different software and devices.

Data is stored in a look up table, used for mapping an input to an output value, to provide information about numerous colour possibilities. Profile maker software uses a colour target to gather information about the device's colour reproduction. A colour target is a set of colour swatches which range in number depending on the software used and user selection. The target is measured and the returned data is used to provide an overview of colour options for the look up table, limiting the amount of data to be stored.



Images of the altered colour targets which were used to create the indicator profiles

Colour Management processes such as profiling and linearization have been developed to maximise a device's achievable gamut. Both these processes use data from the print environment to optimise the print outcome. Linearization uses colour measurement data to ascertain the optimum media (colorant, substrate etc.) settings. Whereas a profile is like a colour recipe, used to transfer data on colour construction to output devices. This aids conversions between RGB pixels of light and solid CMYK dots of colorant.

Both processes require access to colour measurement devices such as a spectrophotometer and specialist software which are expensive and require training for use. At the moment neither process allows you to store information particular to textile substrates, such as the type of textile chemistry pre- and post-methods, weave or fibre type which impact colour outcome. These processes were developed for reprographic and photographic printing where the colorant will sit on a smooth, non-woven, surface which doesn't require fixation other than air drying.

It would be expected that a DPB service would carry out colour management procedures. They may recommend that supplied artwork be assigned a particular ICC profile, generally a virtual device profile, for example Adobe RGB 1998 or sRGB IEC61966-2.1, which have been developed for general colour management use. However, these profiles provide a false idea of colour reproduction possibilities as their gamut boundaries are far wider than the colours achievable using CMYK colorants.

An analysis of profile creation software was conducted to determine whether it was possible to edit profiles as well as generate them. However it was quickly established that the software was complicated and not possible to learn within the timeframe of the research project. Consequently, a more creative option was taken. The colour targets were directly altered in order to modify the information returned to the profile maker software and create speculative colour look up tables.

To create the indicator profiles a colour target, consisting of 1748 swatches used by Printer Cal, profile maker software for AVA CAD CAM, was repeatedly modified in APCC. AVA CAD CAM is a specialist software for textile and decorative surface designers and producers. The modifications were made using existing data and focused on HSB shifts for different substrates as well as red/blue wavelength adjustments and greyscale calculations. The targets were printed onto Cotton Satin and measured. Next, the data was returned to create ICC Profiles using Printer Cal software. Finally, the profiles were assigned to the specifically created colour test collage image in APCC to observe the colour changes on screen.

The four different indicator substrate profiles and two virtual device profiles as comparison

Six colour collages images were examined; four images with assigned indicator profiles modified using data on hue, saturation and brightness shifts for four substrates (wool, linen, cotton, silk), and an additional two, using assigned standard, Virtual Device ICC profiles (sRGB IEC61966-2.1 and Adobe RGB 1998) as comparisons.

Wool: The image has a slightly orange appearance which is most noticeable in the neutral colour ranges. The colours appear muted in comparison with the images assigned with standard generic profiles. Colours from the blue/magenta tonal ranges are most vivid and green tones appear bluer. The neutral ranges has a soft contrast and appears to have a sepia like appearance.

Linen: The image has a slightly yellower appearance which is most noticeable in the neutral colour ranges and in the red tones. Blue and green tonal ranges appear yellower. Neutral tones have a strong contrast but instead there is a loss of tone quality.

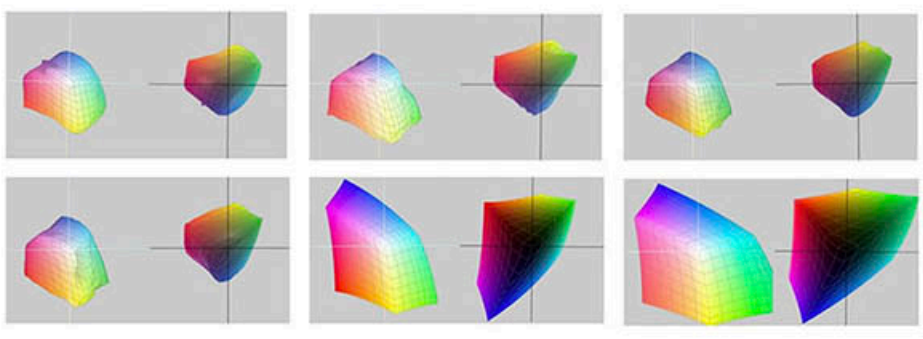
Silk: The image has a slightly magenta appearance which is most noticeable in the neutral colour ranges. The red tonal ranges appear strong and spectral colours are saturated. Neutral ranges appear darker than the linen or wool images, with a strong contrast.

Cotton: The image has a slightly orange-red appearance but neutral ranges do not. The colours are strong and saturated similar to the silk profile except that there is improved tonal quality and decreased contrast which achieves a better colour balance.

sRGB IEC61966-2.1: The image has strong saturated colours in comparison to the indicator profiles with no apparent overall colour tint. The neutral ranges have a slight green quality to them but contrast, tonal quality and colour balance are all good.

Adobe RGB 1998: The image has incredibly strong saturated colours, particularly in the blue tonal ranges, in comparison to the indicator profiles with no apparent overall colour tint. There is strong contrast but a lack of tonal quality. The neutral ranges have no apparent colour tint.

All indicator profiles demonstrated a loss of brightness and saturation in comparison with the standard, generic profiles which is in keeping with the reduced brightness and saturation appearance of printed textiles.



Gooby, B, 2018 Apple ColorSync Screen Grab Profile comparisons viewed from lightest and darkest points.
Top Row L-R Wool, Linen, Silk Bottom Row L-R Cotton, sRGB IEC61966-2.1, Adobe RGB 1998 (Researcher's own collection)

ColourSync comparisons of the different gamut (colour range) that each indicator profile created

These results had some correlation with the findings of visual analysis of differences from screen to print colour using the Colour Reference Book. Linen, a cellulose fibre constructed from flax plants, does not absorb dye particularly well. The juniper linen tested has the loosest weave of all four substrates and whilst colour matches on Linen appear good, the saturation is greatly reduced. Wool is a keratin protein, animal fibre which naturally repels moisture but does absorb dyes. However, whitening pre-treatments are complex and Wool substrates prepared for DTP tend not to be bleached in order to reduce costs. The Wool substrate used in this research is in its natural state which has a yellow undertone affecting the printed colour. Similarly, Silk is an animal fibre and absorbs dye well. The smooth texture and reflective qualities of the Satin Silk tested provided strong colour results but darker than the screen colour. Cotton is cellulose, derived from cotton plants, but absorbs and retains dye well. Like the Silk, both the Linen and Cotton were bleached white in the preparation for print.

The resulting profiles offer a visual indication on screen to designers of the overall colour shifts that may occur when printing onto different substrates. This improves the designer's colour knowledge and prompts colour resolution practice at the design stage, prior to hard proofing, saving time and reducing costs.

The results are subtle and not as apparent as some of the variations in the Colour Reference Book. Colour differences can be obscured when viewed within an overall design as opposed to separate swatches. Yet a designer used to gauging colour changes can utilise the indicator profiles to detect which colour ranges may need adjusting when choosing an end substrate.

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Resources – Test Files

Colour Conversations

A series of discussions, entitled 'Colour Conversations' were conducted to find out how designers were engaging with digital textile printing.

Participants were from a selected group of industry, colour experts through a network established by the researcher. The group included newly graduated designers, established design studios, digital print bureaus, textile design agents, academic researchers and leading designers in the field. Scroll down to the grid to select an interview to read.

A number of themes emerged as a result

Reducing or Controlling Colour Fidelity Variables

The majority of designers interviewed reduced colour fidelity variables by working with one substrate, or a limited number of substrates, which enabled them to build up a colour knowledge-bank in order to make adjustments to the digital files which accommodated colour changes caused by the structure and composition of the cloth.

Designer / Printer Communications

Several designers had built up a good working relationship with a particular DPB having trialled several bureaus and encountered issues such as colour mismatches. Reduced costs or free colour sampling, good colour management communication, such as providing an ICC profile to embed, and consistent results were all cited as important when out-sourcing DTP.

Designer's Eye

All of the designers made tacit adjustments in their digital files to allow for colour changes between screen and print colour. These adjustments were made based upon past experiences, built up tacit knowledge and haptic intuition, as well as digital colour knowledge. Designers talked about adjusting levels, saturation, brightness, mid tones and shadows to control colour.

Colour Management Education and Accessibility

Established colour management practices such as ICC profiles and colour measurement procedures (for example, using a spectrophotometer), utilised by the graphic and photographic industry for digital paper printing, do not appear to be the primary source of colour control for designers working in this medium. Several of the designers were not aware of these processes or did not understand them. The majority did not have access to colour measurement technology such as a spectrophotometer or bespoke DTP software. The designers who did incorporate these controls had greater industry experience, combined additional tacit adjustments on top of these practices, and incorporated customised ICC profiles for their print environment.

Colour Testing

Colour sampling and colour palette testing was shown to be a simple yet useful and accessible method which designers incorporated into their design process. This visual process built up tacit knowledge of digital colour and colour changes.

Entrepreneurial Business Models

All of the designers interviewed felt that DTP had enabled and empowered their business model. Designers cited small print runs, reduced overheads, quick turn-around times and the ability to respond quickly to design trends as reasons for engaging with digital textile print technologies. Many liked the ability to produce innovative and customisable fabric designs for a small, or particular, market which allowed them to test out design styles without the risk of having to hold large amounts of stock which they may have to scrap or reduce if unsuccessful.

> It's a brick wall I have banged my head against for the past three years
>
> — Digital Print Bureau talking about colour in digital textile printing

> I've stopped using black and went for a really deep sort of maroon burgundy shade... I think I've tried to avoid it since or I've warned a client there's a lot of black in here, you need to be aware that that might be problematic.
>
> — Design Professional

> At no point did the printers give me any guidance on obtaining the colours I wanted. I was not for instance provided with a colour profile or a recommended colour space to use.
>
> — Design Professional

> I'd say the washing is now, its always difficult, especially in this country. And for us particularly we're an old company, and a lot of our factories are quite old, and quite open, so really, we have tight

Experimental

Methods

Colour Conversations

Colour Conversation: Studio Flock

Colour Conversations: BeFab Creative

Colour Conversations: BlackPop

Colour Conversations: Bugi Studio

Colour Conversations: Earthed by William Clark

Digital Textile Colour

a research tool-kit

Colour Conversations

Colour Conversation: Studio Flock

by **admin@digitaltextilecolour.org** – 11/02/2021

> "Keeping fabric choices simple and establishing a good relationship with your printer is key to colour outcome"

Flock are a design studio run by Jenny Wingfield. She works with a select range of artists, designers and illustrators to produce a range of pattern designs primarily printed textiles but recently have expanded into wallpapers and rugs. This will require that colours match across a range of products, using different colorants on different types of surface.

Flock Website

A design will start off with Jenny suggesting an initial colour palette to the designer she is working with. Many are from a graphic design background and enjoy the challenge of designing for textiles. Jenny retains creative control and will carry out the colour editing herself using Adobe Photoshop as she has a sense of what colours will be successful and what will fit in with the overall collection. She doesn't rely on a particular colour system for colour matching but has used Pantone occassionally, primarily working directly with the Digital Print Bureau to ensure colour accuracy. Prints are sent for colour sampling initially, which are made at a discounted rate, before final prints are made.

Flock have cultivated a good working relationship with their current Digital Print Bureau. Jenny is confident in their ability to handle all the colour management processes without her input and their established working relationship ensures that they have a good idea of the quality and asethetic that shes looking for. From experience Jenny knows that the substrate has a huge impact on the colour outcome so she uses three base fabrics, keeping certain patterns on the same fabrics to retain a particular look, although customers may specify a fabric if they have a preference.

Jenny has experienced colour issues in the past with a different bureau, when a previously tested print on linen's colours altered when re-printed. When the problem was investigated a change in the weave of the

Colour Conversations

Colour Conversations: BeFab Creative

by **admin@digitaltextilecolour.org** – 11/02/2021

> steaming and washing are the most challenging variables in the digital print process and difficult to control

Be Fab Creative were a Digital Print Bureau operating in Edinburgh, Scotland. They started in 2012 but decided to close the business in 2017 to concentrate on other things. Their web blurb says *"Be Fab Be Creative are a reactive digital fabric printing bureau, printing on a range of cotton, linen, silk and bamboo – specialising in small, bespoke orders."*

Be Fab were the only print bureau contacted who agreed to speak about colour in digital textile printing. Solii wrote about digital textile printing on the Make Works site Scotland and ran their Instagram account where she had a series called 'Print Wednesdays' where she documented prints coming off the printer.

Soli discussed how initially they felt naïve about the process. There is a lack of shared information in the industry which leads to poor working practices and no standardisation. Working with reactive dyes, contending with many variables, most frustrating of which was steaming and coatings which led to problems with consistency.They bought in coated fabrics rather than coating themselves but that was an issue in itself as they experienced quality issues. They also experienced frequent steaming issues because different fabric loads in the steamer would alter the amount of steam that reached the fibres which in turn altered the colour outcome. They soon realised that it is challenging (near impossible) to get the same colours across substrates and so managed their customers expectations when printing on different fabrics. Initial consistency issues they solved by upgrading their colour management system. Their suppliers told them that as technicians they should try to adjust the colour to get the one they think their clients want. But this leads to consistency issues for when the client returns for a repeat print so they didn't want to do this. This practice was something they heard about at other print bureaus and they got a lot of customers who continued to print with them because they got better repeat consistency where they'd experienced poor consistency elsewhere. She felt that pricing in DPBs was too opaque and that many bureaus hid the costs of

Colour Conversations

Colour Conversations: BlackPop

by **admin@digitaltextilecolour.org** – 11/02/2021

> Establish a good working relationship with your print bureau and gain commercial industry experience to become colour confident in digital textile printing.

Blackpop are a design studio specialising in luxury fabric and wallpapers.

Their collections have taken inspiration from a number of collaborations including the Soane Museum.

They undertake a lot of contract work for hotels and restaurants.

www.blackpop.co.uk

Designs are made primarily in Photoshop and adjusted depending on the intended substrate usually British Velvet. Blackpop have a background in reprographics and photographic printing and therefore comprehensive knowledge of digital colour and colour conversion to CMYK printing.

Blackpop have established a good relationship with their bureau and, through requesting details about their profiles, uses these by assigning them direct to artwork and adjusting colours accordingly.

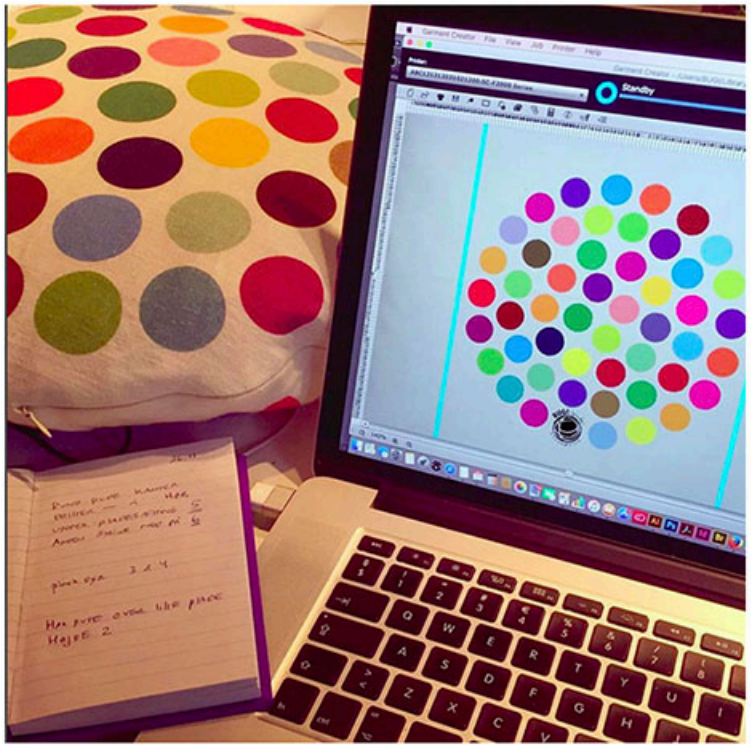
Blackpop believe having commercial experience is the best way to gain technical skills and wouldn't expect universities to teach these to students. They reduce their variables by printing primarily on velvet but occasionally print on silk or offer other fabrics if clients request them.

Colour Conversations

Colour Conversations: Bugi Studio

by **admin@digitaltextilecolour.org** – 11/02/2021

> Colour has been a challenge in digital textile printing from the start but understanding colour and sampling can aid outcomes.



Bugi Studio is run by Danish Textile Designer Helle Abild.

She has worked extensively across industry, particularly in the USA, working for large brands such as Levis in the late 90s when digital print started to be used in industry. She has seen the changes that the textile industry has undergone to incorporate digital textile printing and design and has been frustrated by how long it has taken.

https://bugistudio.com/

In 2002 she wrote a report about the colour issues in digital textile printing after encountering problems in industry. The report set out to establish which colours were printable and looking at design software that flagged whether a colour was out of gamut or not.

In addition to her industry experience, Helle has taught in higher education for over 10 years. She teaches her students to print a range of hues, from light to dark, to compare the printed colour to the screen colour. These experiments extended to different substrates and printer settings so that students could see the differences these made and got into the habit of saving the settings so they could achieved the colours they desired.

She creates her own colour samples as well as using established colour referencing system such as Pantone which she prints onto Epson Heavy Matt paper using her own Epson dye sublimation T-shirt printer. She regularly calibrates her print environment and prints across a range of substrates (ceramics, t-shirts, fabric).

Colour Conversations

Colour Conversations: Earthed by William Clark

by **admin@digitaltextilecolour.org** – 11/02/2021

> Designer's eye and colour expertise help overcome colour challenges. Control over textile chemistry and fabric production is also key to ensuring colour accuracy.

Earthed Fabrics are the creative operation of William Clark, a linen mill. They produce digitally printed interior fabrics. As a mill they grow and produce their own linen which they can prepare from start to finsih for printing.

Their business model of combining expertise in textile construction with digital textile printing has enabled them to branch out into printed textile production and enter new markets.

Earthed Fabrics Website

Creative Director, Duncan Neil, has extensive experience with digital textile printing, first encountering it at university where he used it to print artwork incorporating photographic imagery. His colour palette used really 'loud' colours and he was really pleased with how they appeared on fabric despite the time it took to print. These were the first digital textile printers and production was much slower. After graduating Duncan gained further experience working for a couple of digital print bureaus.

The set up at Earthed is very professional with a high quality digital textile printer and specialist textile colour management technology. From experience Duncan says that the choice of substrate and the treatments it undergoes, both before and after printing, have the biggest impact on the colour outcome. He has done a lot of work to ensure all the textile chemistry is bespoke for the linen they produce and the environment that they print in. Having this control ensures that he is able to get consistent and accurate colours.

Colour Conversations

Colour Conversations: Emma Kendall

by **admin@digitaltextilecolour.org** – 11/02/2021

> Embrace colour mistakes but improved design education would support designers engaging with digital textile printing

Emma Kendall is a freelance designer and illustrator and a recent textile design graduate.

She uses a bright colour palette, frequently including fluorescents. Her style features contemporary florals and expressive mark making. She uses scanned imagery, incorporating photographs, glitter and reflective materials into her work. Her illustrations combine collage and drawings and she has undertaken several mural commissions. Her layering technique features across her work and can be seen in her digital prints.

https://www.instagram.com/emmakendall_lifestyle/

To achieve many of the fluorescent colours and special effects (glow in the dark, flocking and foiling), Kendall hand printed over digitally printed fabrics. She uses a tablet to design with as well as incorporating hand drawn elements, designing primarily in Adobe Photoshop. She uses photography to inspire her design compositions and imagery and translates theses starting points into her 'own handwriting', using paints and ink. These hand rendered elements will then be scanned and manipulated digitally and may incorporate photographic and other scanned imagery.

Emma's first engaged with digital textile printing at university but was not taught a particular method for

Colour Conversations

Colour Conversations: Jacqueline Milton

by **admin@digitaltextilecolour.org** – 11/02/2021

> Colour sampling and testing is key to achieving the colours you want.

Jacqueline Milton is an established designer who has her own range of classic, nature-inspired, soft furnishing fabrics. These are printed digitally using pigment inks on a range of linens.

Her collections are inspired by the environment around her in the Dorset countryside using a natural colour palette such as greens, blues and creams in soft earth or pastel tones with some stronger highlight colours such as yellows, reds and pinks picking out details.

www.jacquelinemilton.co.uk

Jaqueline started off her career at Axminster Carpets as designer and has since gone worked for a variety of companies employed directly as a designer as well as freelance roles before setting up her own studio business.

Jacqueline's industy experience means that she has a lot of knowledge of the textile industry and has applied professional standards to her practice. She has tested and trialled various fabrics as well as print bureaus before settling on using linen and pigment inks and sends her fabrics to the Shirley Institute for finishing tests. She had tried out a few print and sew services but was unhappy with the quality.

She created her own colour chart for colour matching . The chart tests each hue from dark grey to most saturated and is incredibly precise. She uses this as her colour sample test and to trial a print bureau or new fabric and then adjust the artwork so that it corresponds to the settings of the colours she desires. She has found that print bureaus will give a discount for colour sampling when asked.

Colour Conversations

Colour Conversations: Made in Brighton

by **admin@digitaltextilecolour.org** – 11/02/2021

Made in Brighton are a long-established and innovative print design studio. They sell their designs to clients who range from fashion houses to textile manufacturers. The clients then take the designs forward to production.

They bought their own in-house digital ink-jet textile printer which they use this to produce samples and strike offs so that they could show clients how artwork would look on fabric.

Made in Brighton Website

Digital textile printing has revolutionised their business and having an in- house printer has enabled them to respond quickly to new trends and looks. They operate the printer themselves using a standard colour management set up provided by the company they purchased the printer from. They have experimented with steaming and washing processes and noticed that changes to these have a big impact on the colour outcome. In particular they have experienced issues with getting pink, black, red and pastel shades to match the original artwork but adjusting the steaming times improved colour accuracy.

The changing and evolving textile market has had a big impact on their business model but digital textile printing has enabled them to respond to these challenges and be more entrepreneurial.

Colour Conversations

Colour Conversations: Melissa Ougham

by **admin@digitaltextilecolour.org** – 11/02/2021

> Colour sampling and testing prints out on different fabrics improves your sense of digital textile printing

Melissa Ougham runs her own company MoD Textiles having recently graduated in textile design.

Her colour palette features earth colours and her primary medium is screen print although she does use digital print as well. Since graduating she has built up her digital print portfolio because her industry experience has been in digital print and due to lack of access to screen print facilities. Her design process frequently starts with drawing and hand techniques which she will scan in and manipulate digitally

https://www.modtextiles.co.uk/

At University, she was given a strong grounding in digital textile printing with dedicated workshops run by the print technicians. The workshops encouraged students to run colour sample tests before printing and provided them with a colour sheet of achievable colours. Whilst students were not allowed to operate the digital textile printer themselves, they were expected to carry out the secondary processes of steaming and washing so that they could understand the dyes used and the colour implications.

Her own colour management process involves creating a colour palette using painted samples and matching them to her digital palette, continuously referencing this palette through the design process. She'd been taught to print her colour palette across substrates (for instance linen, cotton and silk) because 'different fabrics react in different ways to reactive dyes'.

Colour Archive

The Colour Archive provides information, instructions and downloads to support designers with digital textile printing. It also features a series of documented experiments and examples.

Problematic and Challenging to print colours

Colour Theory: Understanding colour, Colour Systems, Models and Spaces, Contrast Theory, Colour Theorists

Colour Expectation: How might a colour print

Case Study: Interwar Colour

Case Study: Ways of Making Project

Colour Archive

Case Study: Interwar Colour Archive

by **admin@digitaltextilecolour.org** – 11/02/2021

This Case Study observed colour use in textile design during the British Interwar period to create a body of work as a real world test case for the three key methods, developed by the inquiry, Colour Reference Book, Digital Lab Dip Tests and Colour Maps, and Indicator Substrate Profiles. In addition, the study looked at the economic, societal, cultural and technological changes that impacted upon textile design in particular new printing technology, fabrics and dyes during this era to consider whether any lessons might be learned for best practice guidance in DTP.

The British Interwar period was a time of great textile technological modernisation, change and innovation, with the advent of cheap, chemical colorants, synthetic fabrics and the emergence of silk screen textile printing. Britain's house building boom and increased availability of mortgages meant that homeownership and interior decoration were made available to the masses. New modernist concepts of sleek and neutral interiors emerged alongside a brightly coloured 'Moderne' or Art Deco palette, creating a distinctively British 'look'. This contrasted with a darker Victorian and Edwardian palette that also continued. Colour creation entered a chemical sphere with the introduction of bright colours that came with them.

A particular colour palette was identified from examining textile samples from the period through archival research, alongside secondary research, to produce a body of design work. Many of the colours associated with the fashions of the 1920s and 30s, smoky, dark colours, neutrals and strong earth colours, have been proven to be the hardest to replicate in DTP. The resulting body of work was used to test the three methods developed by the research inquiry, the results of which were documented and recorded.

The exercise set out to compare the development of colour use in textile design during the Interwar period and create a body of colour work to test a number of methods developed by the inquiry.

Photograhps from Crysede archive – Colour sample chart and page from sample book

Ushering in Technological Change

The period after the First World War saw huge economical and societal changes. A house building boom and the introduction of mortgage loans made available homeownership, and therefore interior decoration, to much of the British population. The middle classes were on the rise with money to spend in the new department stores on furnishings and ready to wear clothes. Commercial CMYK paper printing, developed in the previous decade, reduced the cost of colour prints which allowed the public to see accurate, colour images in the new home decoration and fashion journals, influencing taste and style. The first colour forecasting and trend agencies were set up to inform manufacturers on consumer tastes. A British 'look' emerged, a more colourful version of continental modernist trends. Organisations such as the Design and Industries Association and the British Colour Council sought to champion 'good' design standards in partnership with industry innovation, a modern follow on from the British Arts and Crafts movement.

Colour creation entered a chemical sphere with the introduction of bright colours that came with them. The bolstering of the British Chemical industry by the formation of British Celanese Ltd in 1912 and Imperial Chemical Industries (ICI) in 1926, benefited by the decrease of production in Germany post First World War. Protectionist economics saw the implementation of a general tariff of twenty percent on manufactured imports in 1932 increasing sales of British textiles within the home market and furthering businesses like Warner and Son who took advantage to grow their fabric printing business by incorporating a screen print workshop, producing their first silk screen print "Shubbery" by V Muller in 1931. A huge number of women, whose male counterparts had been killed or maimed in the war leaving a surplus of unmarried women, turned to work with textiles and interior decoration, deemed suitable jobs for women. Artists turned designers in order to generate income in a time of economic instability, with Allan Walton Textiles, Edinburgh Weavers and Omega Workshop championing artist led design. The employment of freelancers, predominantly women, gave manufacturers the opportunity to test out modern designs, without having to provide financial commitment. The British Colour Council, established in 1930 by Robert Wilson, responded to a need for standardisation, producing a Dictionary of Colour Standards for the textile industry.

In 1931 the International Commission on Illumination (established in 1913), defined the CIE XYZ colour space, a revolutionary mathematical model of the visible spectrum. Le Corbusier's desire to control colour for his vision of 'polychromie architecturale' led to the creation of his colour harmony selections, 'colour keyboards', and coloured wallpapers which ensured he maintained control over the colours within his designs, a step away from builders mixing up paint from powder on site which could lead to colour discrepancies. In a survey of colour trends of the period, Derek Patmore wrote 'once the rules of colour have been mastered, the decoration of the home need not be expensive or ugly '. The principles and rules of colour had never been more widely studied or available.

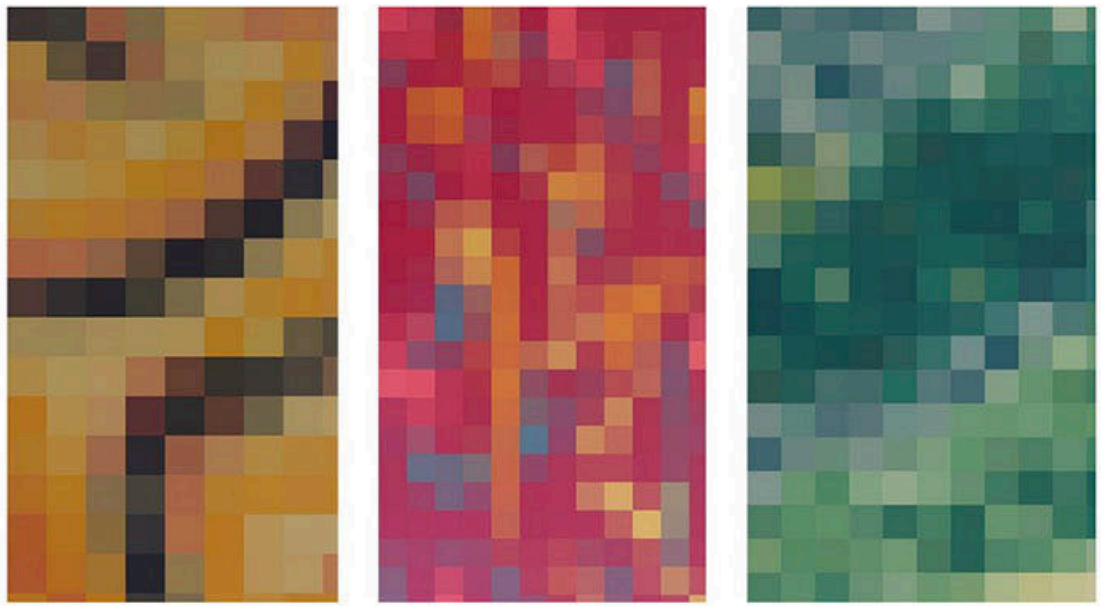
An initial survey of research on the British Interwar period established a number of key, accessible archives to visit including the Victoria and Albert Museum (V&A) archive and Transport for London's Acton Depot which holds the moquette seating collection. Further research uncovered Eileen Hunter, a freelance textile designer working in the 1930s and whose archive is held by the V&A. A visit was made to the Crysede archive in Cornwall, a high end fashion house from the English Riviera's Jazz Age.

Crysede

Crysede produced high end fashion pieces in the midst of the modernism of the 'Cornish Colonies' in the 1920s. Outside of London, this arts and craft movement was concentrated around the activities of the St Ives School and Newlyn School of painting. The designs were illustrative and influenced by textile designs of Raoul Dufy and Paul Poiret. The dyes were British synthetics, bright and colourfast.

The archive holds several colour sample sheets, some on coloured grounds (blue, red, yellow-brown, green-white) with rows of coloured circles starting with the standard dye colour and then lighter mixes of the hue with notes on the proportions. Some of the colour names are very evocative of the 'moderne' era, for example Tango, New Flame, Picasso.

A number of colour studies were made based on photographs and sketches and used to create a Crysede Colour Palette, rich with strong earth colours and bright hues which was applied to an illustrative design, inspired by the Bristol landscape.



Colour studies made after visit to Crysede Archive

Transport for London Moquette fabrics

The Managing Director of London Underground in the 1920s was Frank Pick, a leading medieval modernist who founded the Design and Industries Association and subsequently the Council of Art and Industry in 1934. Pick commissioned much of the now iconic branding for the tube. His favourite colour was green and the colour palette for the moquette fabrics used to upholster the tube seating was primarily green and red. Dissatisfaction with stock moquette prompted Pick to employ prominent designers Paul Nash, Enid Marx and Marion Dorn to create bespoke designs.

The designs were primarily dark colours with accents of bright red and light green. Many of the designs were tonal using a dark and mid tone of a colour such as green, pink, brown or blue with an accent colour. It must be presumed that there will have been some colour fading due to the age of the fabric samples.

A number of colour studies were produced using photographs and sketches and used to produce a colour palette of strong, dark, earth colours, forest green, sage green, dusky pink and chocolate brown and accent highlights, red and sky and navy blues and applied to several geometric designs.

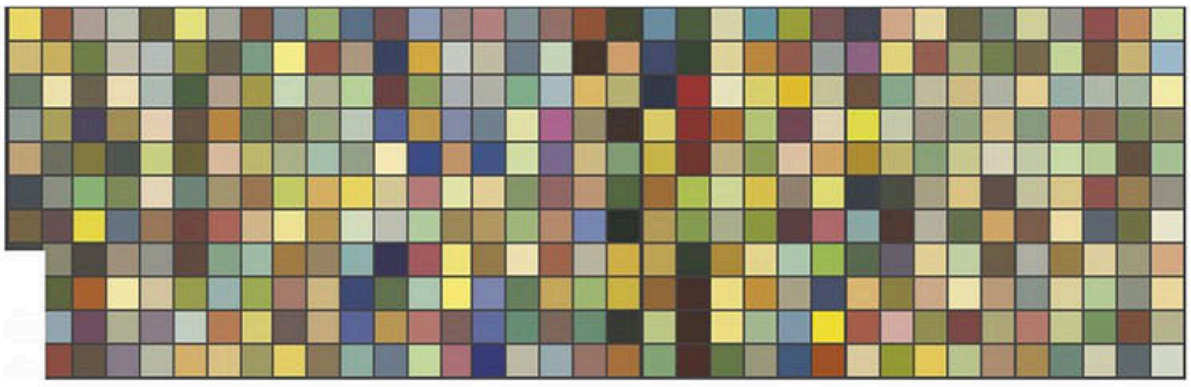
Eileen Hunter Archive

Hunter donated her archive to the Victoria and Albert Museum but the fabric swatch books were not available for viewing because they were on loan. Hunter was a freelance textile designer in the 1930s designing for soft furnishings and interiors. Some of the designs had names such as Apollo and Cornucopia but most had a numerical reference. Hunter's colours were bold using strong emerald green, tonal pinks, marine blue and purples. Hunter was unusual in that she set up her own textile studio rather than working freelance. Boydell classifies the 1930s as the rise of the female freelancer where design studios began to buy and commission freelance designs primarily because it was more cost effective. Freelance work did not pay particularly well and Boydell writes that Hunter set up on her own to maximise her income.

Several designs were created inspired by Hunter's illustrative style and printed in several colourways using a colour palette derived from examining paint sample collections from the interwar period and Pantone's guide to historical colour use.

Further Material

In addition to the archive visits the inquiry sought to examine material related to Interwar period through visits to exhibitions and reviewing primary and secondary textual sources including Pantone's History of Colour and Patrick Batty's Anatomy of Colour and the work of Colefax and Fowler, society decorators and the Omega workshop, artists turned designers.



Method testing

A sample of each colourway for every design was printed onto the four test substrates (wool, linen, cotton and satin) and compiled into two sample books. Visual analysis of the fabrics was conducted and the books were annotated with observational comments.

Twenty colours from these prints were identified as the most problematic, reducing the number of colours to consider. These colours were translated into the closest Pantone reference match using the colour picker tool in APCC. It became apparent that several of the colours were very similar, reducing the colour set to 14. The colours ranged from dark earth blues and greens, a range of neutral achromatic colours, strong earth reds and yellow and a number of paler purples and magentas.

Colour Reference Book

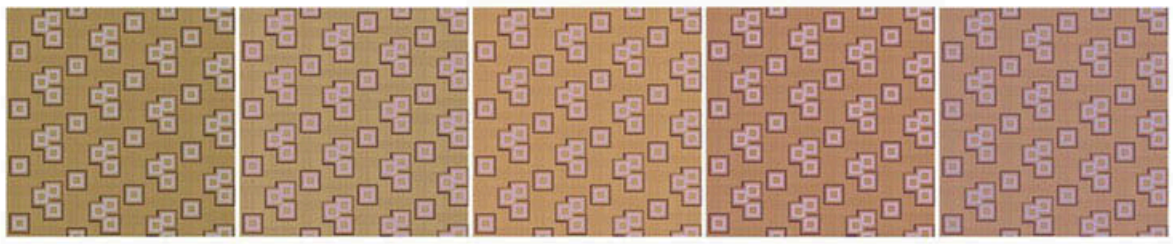
The printed designs were compared with the corresponding swatches in the Colour Reference Book to see whether an examination of the individual swatches would have identified that these colours would have been a challenge to print. The observations recorded and documented. Several of the Pantone colours were considered to be a poor match for the original challenging colour highlighting that algorithmic conversions between colour spaces can be problematic. Therefore of the 14 in the challenging colours set only 6 of the Pantones were close matches to the original set of 20 identified in the sample book. This 6 was taken forward to the next stage of testing. The colour set consisted of a dark earth green, light earth green, dark grey, strong earth red, bright pink and a pale earth yellow and the corresponding swatches in the book closely resembled the colour outcome in the printed samples, supporting the book as a useful reference tool.

Digital Lab Dip Tests and Colour Maps

A digitised lab dip test was created for these 6 colours, 1 per substrate, measuring the corresponding swatches in the Colour Reference Book with an Xrite I1 Spectrophotometer returning LAB data. The digitised swatches were plotted onto the Colour Map template, consisting of four swatches per colour. A complementary colour map with an indicator colour was also created using mean average data. Of the 6 hues, 4 offered a good indication of how a colour might print in comparison with the printed samples and swatches, and 2 did not. All of the swatches showed a loss of brightness and saturation and a movement in hue value, in line losses in the initial colour map exercise. The 2 colours whose indicator map was not a good match to print outcome, were the dark grey and the bright pink. The pink swatches, Pantone 5155, had considerable hue value differences to the screen colour.

Indicator Substrate Profiles

Finally the four different indicator substrate profiles were applied to all fourteen designs from the problematic colour set. The differences on screen were next compared with the printed versions to determine whether there was a considerable likeness proving the indicator profiles to be a suitable proofing method. The observations were recorded and documented. When the profiles were applied to 9 of the designs, visual analysis indicated that the profiles were a good indication of the impact a substrate had on print outcome. 5 of the 6 colours taken forward to the mapping stage also demonstrated that the indicator substrate profiles were a good indication of print colour outcome. The pink hue, Pantone 5155, had a good tonal match but not hue match on screen to the printed outcomes. The other 4 designs were from pink, red, green, yellow and brown colour ranges and therefore similar to the 5 mapped colours. The indicator profiles did not offer a good indication of print colour across substrates on any of the blue, purple or pale achromatic colours.



london transport design 4 colourway 13 jpglondon transport design 4 colourway 13 cotton ... london transport design 4 colourway 13 linen p... london transport design 4 colourway 13 silk pro... london transport design 4 colourway 13 wool p...

Analysis

Colour Reference Book

Colour conversion issues between software (AVA to APCC) and colour spaces (LAB to Pantone) made it difficult to assess a broad range of colours from the challenging set. However the 6 that did appear a close match to the corresponding Pantone reference additionally demonstrated a clear match between the swatches and the samples.

Digital Lab Dip Tests and Colour Maps

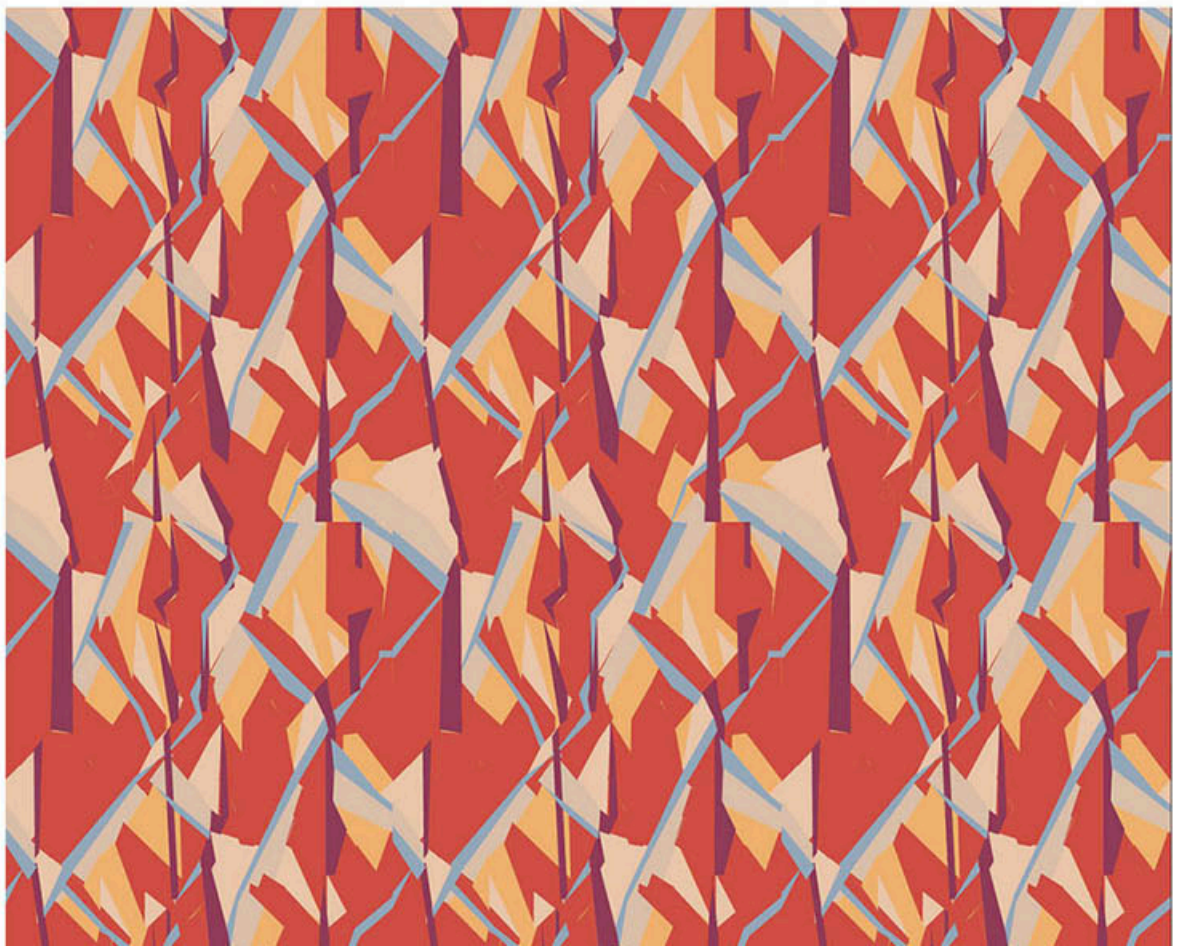
Likewise only 6 colours were tested and of these 4 demonstrated that the indicator colour was a good match to the printed colour outcome in the samples and swatches.

Indicator Substrate Profiles

Whilst 9 designs demonstrated that the indicator profiles were useful for proofing, 5 were not. These 5 had challenging colours from blue, magenta and neutral achromatic ranges which had previously been highlighted as particularly challenging to print.

Summary

The reduction of the colour set due to the conversion issues meant that a broad range of blues, magentas and achromatic colours were not able to be analysed as part of the Colour Reference Book or Digital Lab Dip Colour Mapping tests. Colours that were tested demonstrated that both these methods could be useful, although there were some anomalies. The indicator substrate profiles additionally appeared to be a useful proofing tool but not for all colour ranges. Likewise further work would be required to support print colour knowledge around some of the more trickier to print ranges such as blues, magentas and neutral achromatics.



Colour Archive

Case Study: The Ways of Making Project

by **admin@digitaltextilecolour.org** – 11/02/2021

Photographs of Ways of Making Exhibition at Royal Academy of Art London April 2019

A number of prints were made for the Ways of Making Project which applied knowledge developed through the research inquiry; indicator profiles and multi pass printing. The experiment set out to explore the creative portential of digital textile printing through the application of experimental profiles and multipass printing. The application of the experimental profiles in particular aimed to transpose colour fidelity by deliberately altering colour data so that it would not achieve a correct colour match to the image seen on screen.

The *Ways of Making* Project is a collaborative project between Sir Peter Blake, Worton Hall Studios and the Centre for Fine Print Research, UWE (CFPR). The aim was to create an archive of every known medium, exploring edition making through creating multiple versions of an image through a variety of processes.

To determine which mediums were of interest to the project, researchers at CFPR were initially asked to make a print from images provided by Blake. These prints covered a wide range of disciplines which are explored within CFPR. For example, robotic drawing, etchings, 3D printed models, and digital textile printing. Two sample digital textile prints were made, one on silk satin and the other on juniper linen. The substrates were chosen by the researcher because of the interesting aesthetic qualities. Prints on silk produce vivid colours, and the silk satin selected was highly reflective with a tight weave. In comparison colour prints are muted on linen which does not absorb dye well. Linen cloth has natural slubs and a looser weave creating a distressed quality to printed images. The images were printed using standard colour management settings, with an sRGB IEC61966-2.1 profile applied, using a digital textile inkjet Mimaki TX2-1600 printer, with reactive dyes (Cyan, Magenta, Yellow, Black, Light Cyan, Light Magenta, Red and Blue). A number of mediums from the work presented by CFPR were chosen to form part of the *Ways of Making* project and final prints commissioned, including a number of digital textile prints on silk satin.

The project brief asked researchers to reinterpret Blake's visuals through their print discipline, drawing upon their particular knowledge and skill set. Consequently, a number of digital textile prints were made which further modified Blake's visuals through the application of ICC profiles developed by the researcher and outlined in the Experimental section of this paper. In addition, several multi pass prints and two pattern repeats were produced, printed on silk satin.

Modification: Colour Information altered through the application of experimental colour profiles

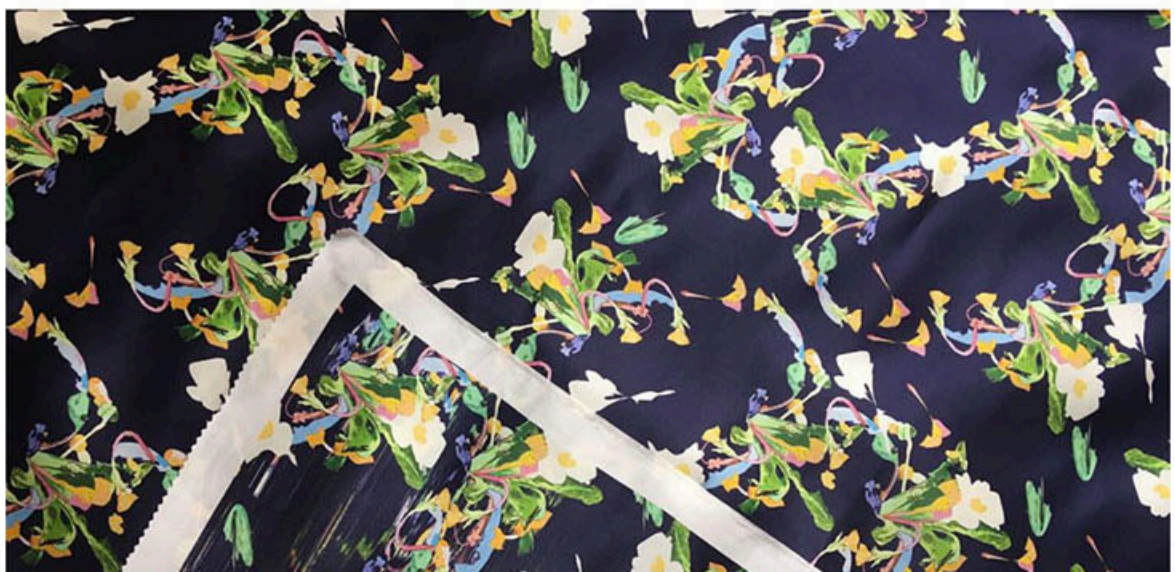
Digital images use a profile, like a colour recipe, to transfer data on colour construction to output devices. This aids conversions between the colour mix on screen (RGB – red, green and blue pixels of light) and colour representation made by the printer (CMYK – cyan, magenta, yellow and black dots of colorant). These two colour spaces overlap but there are many colours possible on screen that cannot be replicated in print, and vice versa. The profile will provide information about how to print such out of gamut colours, varying the colour outcome. A series of profiles were applied to eight images of a primrose provided by Blake, producing forty prints. The profiles altered the colour data to create experimental colour modifications

Adobe RGB 1998: Virtual Device profile	A generic, standard profile developed by Adobe to maximise the potential for CMYK (printer) colourants to capture as many of an RGB (screen) saturated hues. Prints are bright and colours vivid.
Experimental Profile 1: Red-Blue Profile	Digital fabric prints were shown to reflect a greater amount of higher, red wavelengths, and absorb more of the lower, blue wavelengths, than digital prints on paper, altering colour perception. A profile was developed using data which examined these differences in reflected and absorbed spectral wavelengths to adjust the red and blue balance of a profile target. The resulting profile produces deeper blacks, deepens blue hues and shift reds towards magenta tones and yellows towards green.
Experimental Profile 2: Silk Profile	Silk satin is highly reflective and finely woven fabric which produces vibrant, printed colour. Silk fibres absorb dye well promoting colour saturation and can yield brighter than intended, brash colours. A profile was created using the measured Hue, Saturation and Brightness differences between screen and printed colour swatches on silk, and applied to a profile target to reduce the potential for colours to appear garish. The resulting profile produces strong colours which have a warm blue undertone, whilst blacks and neutrals have a softer appearance.
Experimental Profile 3: Grey Profile	Grey profile – CMYK prints create greyscale by printing equal amounts of cyan, magenta and yellow dots, which theoretically should be perceived as tones of grey. However, spectral quality issues with cyan colourants lead to a magenta dominance in colour perception, resulting in pinkish greys. A profile was developed using measurements of the differences between screen and print hues in the greyscale range. These were applied to a profile target, radically altering the measured target colour set, and consequently the profile. The resulting profile produces saturated, pink images with fuzzy tonal and image quality. Large greyscale areas have a shimmery appearance.
Experimental Profile 4: Grey Profile Two	The grey profile was applied to the image set after greyscale conversion, discarding all original colour information. This produces a subtler effect with an overall cooler, colour temperature.

Additionally, two types of multi pass print were made. DTP creates prints in a single pass. The print head travels across the fabric depositing cyan, magenta, yellow and black colourant in a matrix of tiny dots to produce what is perceived as a full colour print. The prints, a layered method which printed key colours as separate layers, and an overprint, where the primary palette was re-printed on top of a single pass print, were observed to have a visual 3D effect. Finally, two pattern repeats were generated using one of Blake's primrose paintings as a motif.

Multipass: Overprint

Multipass: Colour Seperation



Appendix F
Colour Conversations

This appendix consists of the edited transcripts and questionnaires that make up the Colour Conversations Case Study. The conversations occurred primarily in 2017 with the exception of a visit to Made in Brighton early 2016, conversation with Dr P Henry, Dec 2016 and conversation with BeFab, Feb 2018.

One participant asked to be anonymised. Their name has been replaced with descriptor and references in the text that could identify them have been redacted (X, [Research Project] or removed (….).

The transcripts features an initial summary of the conversation with relevant timepoints, and further information about the participant (where permission has been given to feature their name), before the full transcript. Content in the transcript has been highlighted in green where it was felt pertinent. Timepoints are in orange. Where there are two or more timepoints listed in the summary refers to different occasions during the conversation where a topic has occurred.

Text in the questionnaires is highlighted in green where the response is about the participant's personal experience, and red where the response is about student experience and DTP education

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Colour Conversations Transcripts

Be Fab Creative – Digital Print Bureau

Interviewee: Solii Brodie from Be Fab Creative – Digital Print Bureau
Interviewer: Becky Gooby
Date of Interview: 10th February 2018
Method of Interview: Audio Call
Consent given: Yes
Transcript approved: Yes
Recording in 200210 Interview with Soli from Be Fab Creative – a digital print bureau.m4a

Duration 25 minutes

Summary

Brodie discussed how initially they felt naïve about the process. [5.54] [6.16] There is a lack of shared information in the industry which leads to poor working practices and no standardisation. [3.35] [4.02] [21.31] Working with reactive dyes, contending with many variables, [7.39] [9.00] [10.50] most frustrating of which was steaming and coatings which led to problems with consistency. [1.39] [2.07] [2.53] They bought in coated fabrics rather than coating themselves but that was an issue in itself as they experienced quality issues. They also experienced frequent steaming issues because different fabric loads in the steamer would alter the amount of steam that reached the fibres which in turn altered the colour outcome. [8.28] [9.17] [9.39] They soon realised that it is challenging (near impossible) to get the same colours across substrates and so managed their customers expectations when printing on different fabrics. [3.46] [5.27] Initial consistency issues they solved by upgrading their colour management system. [6.37] Their suppliers told them that as technicians they should try to adjust the colour to get the one they think their clients want. But this leads to consistency issues for when the client returns for a repeat print so they didn't want to do this. This practice was something they heard about at other print bureaus and they got a lot of customers who continued to print with them because they got better repeat consistency where they'd experienced poor consistency elsewhere. [7.53] [9.39] She felt that pricing in DPBs was too opaque and that many bureaus hid the costs of reprinting and editing to get colours correct through ink prices. [10.20] She detailed their working practice of using Pantone ranges to match colours with but found them not to be very accurate because the range was so broad. [13.05] She cited the subjectivity of colour and colour perception as an issue. [13.44] They recommended art work was saved in an RGB profile. [14.40]
She talked about the problems of printing on very sheer fabrics and how the weave of the fabric affects the colour because of the amount of ink that can be held by the fibres. [11.19] [16.09] [16.59] She felt that many clients didn't understand the difference between how colour was represented on a back lit screen and printed colour. [17.37] She suggested using the vibrancy tool as a key way of getting brighter printed colours. [17.55] [18.38] Finally we discussed colour sampling and how they recommended printing part of a design first as a way of sampling rather than colour chips or a scaled down version because of issues with laws of colour contrast. [19.51] [20.42] She also touched on dye sublimation and how whilst the colour quality was better it had poor fastness for washing, light etc. [23.25]

About Be Fab Creative

Be Fab Creative were a Digital Print Bureau operating in Edinburgh, Scotland. They started in 2012 but decided to close the business in 2017 to concentrate on other things. Their web blurb says "*Be Fab Be Creative are a reactive digital fabric printing bureau, printing on a range of cotton, linen, silk and bamboo - specialising in small, bespoke orders."*
Solii wrote about DTP on the Make Works site Scotland and ran their Instagram account where she had a series called 'Print Wednesdays' where she documented prints coming off the printer.
The Make Works Profile blurb says
"Typical clients include a wide range of established designers, design students, small businesses and designer makers who have a passion for fabric. A basic understanding of the process is fine, but it is great if you understand technical specifications for your project (e.g file types or quantities). You can upload jpeg's to their website up to 50mb, For larger files they use Tiff format (so please contact them for instructions for sending). The width of the fabrics varies, and fabric types can dictate the length of a single piece that can be processed."
Weblinks
https://make.works/companies/BeFabBeCreative
https://www.instagram.com/befabbecreative/
https://make.works/blog/guide-to-digital-fabric-printing

Becky: I thought I better explain a bit about what I'm doing first. I started PhD in 2015 having worked as a textile designer and sending off my designs to be printed I was [Redacted DPB E], did you ever come across [Redacted DPB E]?
Solii: I know the name but I don't recollect meeting her
Becky: I think sadly her business has gone under and shes moved onto doing something else. They were based in East London and that's where I was doing my Masters at the time so that's why I was using them. I was sending designs off and then printing them on different substrates, like something on silk, something on linen and then getting back different colours and going Oh God I don't know why. And then having spoken to other textile designers and them going oh yes we don't know why either how the colours print in digital printing either but its very expensive so we just go oh ok lets just go with this because we've spent so much money so I thought I'd do a PhD to try and investigate why the colours are different
Solii: Sounds a bit like a minefield
Becky: Well it is!
Solii: It's a brick wall I have banged my head against for the past three years
Becky: So yeah I've realised its really complicated and theres a lot of variables that are involved. The stuff that's been set up is all to do with paper printers and textiles hasn't really been considered. So yeah I'm about to hopefully publish my thesis and I've put together an online toolkit which talks about the different variables involved and what impact they have on colour and why. But the people I've not managed to get anybody to speak to me yet, are the digital textile print bureaus and I'm presuming that's to do with commercial sensitivity
[2.21]
Solii: Yes commercial sensitivity but its also very busy, trying to keep your head above water generally. But also, this sounds really bad, but having spoken to many of them, and textiles is such a close industry, there is this fear of industrial espionage so why would we share that information rather than for the greater good kind of thing but yes unfortunately its mostly because of industrial espionage. The [Redacted DPB A] are a total delight they're lovely but its not information that they'd share because the information that you're giving out might be used by their competitors but its normally googling answers to questions when it comes to fabric printing question.

[3.35]
We had a couple of incidences, particularly in our first few years, we had a couple of different people contacting us just wanting information really interested and actually they ended up setting up their own bureau
[4.02]
So we thought ok never mind we're not going to play this game any more so unfortunately there are some shits out there.
Becky: What I've come across is it just seems to lead to a lack of standardisation. Everyone is doing their own things and they're almost trying to do it by magic or telepathy and it would be good if information was shared because you could find out what was working and you could be a bit more creative or I don't know
[4.40]
Solii: Yeah I think theres the other element of every bureau will have a different software that they're working with, print server, and when we set up we did all of our colour profiling with a spectrophotometer and so that gauges all the colours. What we were originally told because we are closing up I'll give you a lot more information than I would have normally done.
Becky: Which is sad I'm sorry
Solii: No don't worry its fine.
[5.13]
So yeah using spectrophotometer there was this element of to give you a bit of background my sister and business partner is a scientist by trade, so she did biomedical science and shes also worked in the IT industry so she was like its science, colour is science, theres the digital side of things so therefore there should be a really clear outcome at the end of it and there isn't really any variables in theory and therefore the output is x. It doesn't work that way.
[5.54]
As you probably worked out. So we were like right ok we want to make sure all the colours are the same across all the fabrics which is what you were sort of discussing the same on silk and linen you can print the same profile onto it but it comes out differently.
[6.16]
So part of the reason for that, in the same way if you print on glossy paper and matt paper it's a different colour it's the same colour but it looks different because its reflected differently. The amount of ink that's held on the surface of the paper or in our case fabric is absorbed differently so theres a whole load of variables there
And I apologise if this is information that you already know so stop me if
Becky: No carry on
Solii: And then the incredibly frustrating variable is the steam so when it comes to reactive digital printing, what were you centring on for your thesis was there a particular type of printing?
Becky: So primarily the experiments I've been able to do are with the equipment we have at UWE so that is Mimaki using reactive dyes and we have a steamer which is used for, it's a star steamer so its used for various types of dying and printing but the digital printed fabrics are steamed in there as well.
[7.39]
Solii: Yeah so when it comes to reactive if you're looking at sublimation or basically surface print heat set. I imagine. I haven't worked with it. That it sits on the surface and you're getting a bit more of initially a reliable result because its printed on the surface like a vinyl although the tech has got better now so its less vinyly but its heat set so you get a better more reliable colour
[8.17]

whereas with reactive inks they're bonding with the fibres so theres a whole load of variables that you can't control or science out because if a linen we had some fabrics we worked with dutch engineers, they were like that fabric is aquaphobic and we were like aquaphobic brilliant its afraid of water. It doesn't absorb as well so its got a waxy finish to it so its not taking in the fixer which is the padding which is on the fabric before hand
[9.00]
and then by association it doesn't take in the ink as well and those two don't react as quickly and the steam doesn't get into it as much so all of those little in theory in each stage relatively inconsequential add up to a degredation of the colour not as vivid. So there were certain fabrics. So you'll know Whaleys were one of our suppliers which is quite a good reference point as some of their fabrics and in theory all of them are padded to work

RECORDING ONE FINISHES
NEW RECORDING
Solii talks about a previous supplier

Solii: And they weren't coming out nearly as vivid and other times they would. And again this could vary from batch to batch. The people who often the most problems we had were the people doing the padding don't necessarily have the stamping of the end product or how the actual digital printing side work they are just people who apply a coating to the fabric They're told what the chemicals are for instance we had one instance where the fabric was the finishers who were putting the padding on the fabric didn't realise one of their heaters were broken so instead of there being three heaters slowly drying fabric as it came out of the padding they only had two. So they raised the temperature of the other two which actually well not burnt but degraded the padding which meant when you put it through the steamer the reaction didn't happen because it degraded that chemical reaction and then it was washed out so we spent a couple of months we were always the people going 'theres a problem with your fabric' and them saying 'no no no there isn't' and we said 'no there is we might be the first but we wont be the last to tell you this' and yeah so eventually they were like yeah you're right there is a problem and we've worked out what it is.
[1.39]
Becky: At least they admitted it
Solii: Yeah, exactly so there's those elements as well that you have as a printer that you have no real control over unless you're [Redacted DPB B] or [Redacted DPB A] because they have their own padding facilities and that's why they have their own padding facilities because they got so sick of being beholden to people who didn't really understand the process so
[2.07]
Becky: I spoke to a linen mill who'd done something similar. They'd started having their own padding made up for them and they coated it themselves because they were having such issues buying in precoated linen.
Solii: Yeah so unfortunately theres been a lot of variables come from the coating side of things and people not doing the coating for the relevant fabrics so using the same coating for all their cottons, and linens and silks but some of them had more waxy surfaces and need longer in the stem and things like that so those are things that you don't necessarily have control unless you're doing that process.
[2.53]
But when it comes to the colour matching and matching a linen to a different cotton or a silk often I think it's the case of realistically, this is going to sound really bad, I think peoples

expectations of a satin its never going to look that red its never going to look the same as linen union because it absorbs light differently so when you put it next to each other actually its not the same because you put it next to each other in colour but actually when you think about putting it next to a photo quality paper next to a matt paper its not going to be the same either so you're getting I think when you start referencing that people start to go ok right.
[3.46]
Becky: So that's how you managed your customers expectations by explaining it that way?
Solii: Yeah and I think it is about, we had to limit our expectations early on. I'm not a textile designer I'm a product designer. That's my background. I came to it through working for habitat for 10 years between their product design department, their training department and retail side of things so Id been to lots of manufacturers and then I would do trainings on how things were made and do trainings on that. So I'd go back to the retail sector and do all the exciting stuff on how things were made and things like that. So I knew textile processing quite well but I wasn't a textile designer, it was probably one of the only things we didn't cover in my degree. Hilariously part of my final project was textiles related so its always been a passion of mine but yeah. So it was this very very quick learning curve of well hang on a minute.
[4.49]
And the other thing that happened when we first set up was that our lovely dutch suppliers we got our printer and our print server the standard one and we didn't question that and we did all our checks with our spectrophotometer and came back and printed our first prints and it was round about Dec and we were printing things that instead of the red being red it was orange and instead of the blue it was coming out purple and basically the colours weren't coming out as they should be.
[5.27]
As a product designer and my sister whose a scientist we were like what the hell and I remember having this very sarcy conversation with our lovely and they were brilliant and we had a very good relationship with them but they were like well what you do is you just choose the colours that you think the designers want. Sorry what! No that's whats in the file why would I make a decision on behalf of them when the information is in the file the detail is sitting in the file so that should be whats going to the printer. And yet again here I was sitting here baffled having a conversation with a dutch guy who doesn't get Scottish sense of humour. No sorry if I have a client who wants to print santa hats they need to look like santa hats not orange hats. And he was like yes. So we ended up having to invest a couple of thousands pounds more which when you're starting a business is a lot
[6.37]
of your own savings which is a huge amount of money. To get better print servers which explains why in that case so if you were finding when you were printing with different people. So again we set up we had a good couple of people who were coming to us who were saying I can print on one fabric one week and print on the same fabric the next week I print on the same fabric I get a completely different result
[7.09]
and we were like well actually what that is is the print servers that a lot of standard bureaus are using you have a technician whose going I think that's the colour they're going for so they adjust the file differently. Say Sarah adjusts the file on a Tuesday one way and then Tom prints it next week because he's the technician in charge and they're not using the old file to get consistency then you're going to get different results. So we'd get loads of clients coming to us going how am I getting different results. I'm ok with it and were on board with the fact that each fabric would have a variation because they're not the same fabric.

[7.53]
And because theres a steam element involved so you can never completely guarantee the same amount of steam hitting the fabric depending on the length of the fabric and actually the temperature of outside of the steamer and the air pressure.
Becky: Yes that's what I've come across before. People saying and when I took it from the machine and transferred across the room it depended on what the weather was like that day.
[8.28]
Solii: Genuinely. We actually thought we were going mad at one point because we were like is it this could it be that and then actually we thought it could be the pressure inside because the steam pressure of steam stents is different so there's all sorts of bizarre things that you're never going to be able to get an exact science from when you're working with steam because also if you're printing a metre one day and twenty metres another day so in a roller steamer that's different to a stent steamer you're going to have more of an unreliable because the steamer hits that fabric for a certain length of time whereas in your star steamer which is a bullet I imagine then the bit in the middle, so the two outer edges are going to get more steam than the bit in the middle.
[9.17]
So obviously depending on the length of that fabric that will depend on how much steam circulates within the star steamer, so yeah loads and loads of variables. But yeah basically what we were also finding that were a lot of the bureaus were actually having technicians change their files because they were working with really standard software. That was just the standard in industry
[9.39]
That's mental which is why you'd get instances where I don't know now whether people are still quoting for prices but the idea of quoting for a job based on how much ink you'd be using. I mean the ink is such a tiny proportion of the cost, like pennies in a metre, so to quote the cost is odd but actually what people were doing were quoting the cost of how complicated is the file and how long its going to take me edit the file to what I think you want but they couldn't say that
[10.20]
so they were saying we'll have quote the cost of how much it will cost to print that file where as its actually the editing and a lot of the consistency issues certainly and I don't know whether that's changed because I haven't used any small bureaus, we didn't do any competitor research in the last couple of years. I think that has a major issue as to where the variables were happening
[10.50]
And if you were, if you have a different profile for your silk from your linen which we did because you can't put as much ink onto a linen as you can a silk because it doesn't absorb as much and then you get into thinner silks as well so that takes down the percentage of ink
[11.19]
I'm kind of on a conscious stream I'm not sure if any of this is what you want to know
Becky: No its really helpful
Solii: I'm not entirely conscious of a straight line. But yeah so. I mean is there anything you found that you've got questions about that maybe I could help demystify?
Becky: Well yes I suppose one the things that I've been trying to look at that, because I haven't managed to get many people to speak to me is what kind of advice different print bureaus have on their websites about colour management and I've been reading quite a lot of stuff by Deborah McKeegan who was from surface pattern print and I think that has stopped and she's

saying that one of the issues is the communication between print bureaus and designers, their customers, are really poor partly because theres this kind of language barrier because people don't know what to ask and many bureaus have been set up by people who have not got the textiles knowledge to be able to talk to the designers in their language terms so what kind of advice did Be Fab give people? I mean you've talked about managing expectations.
[12.26]
Solii: Yeah so we tended to work on the basis that we matched pretty well within a tolerance because you always have to caveat. within tolerance to pantone uncoated colours that's kind of what we worked to. If you work with coated then that means its not going to work because fabrics aren't glossy so that's really kind of where we were. We had our pantone book so if there was ever any issue then you could have a check but then again pantones have their flaws because if you look on a colour picker then take a pantone actually the pantone has got a range which in some cases is really broad
[13.05]
so we could be like yeah it does sit within the pantone but actually if you put in another plus 100 in vibrancy it will still fit in the pantone so that was difficult as well. Colour, as you well know, colour is a degree phd in itself, just in the science of the make up of it and how the brain perceives it. Do we all see the same colour the same way so yeah so that was our kind of standard tack of what we matched to
[13.44]
Becky: and did you recommend that people had their files in a particular colour space, like Adobe RGB
Solii: It had to be RGB. RGB is a larger colour profile so if you put them in CMYK you would come out quite muddy. So yeah RGB was definitely. Entreatingly I've had quite a few arguments with paper printers or people who work with paper printing more than fabric printing who say this is ridiculous its not standard. You're like do you want me to put it in a lesser profile because and by that then they start going off and find out that RGB is a wider profile and then they go and do their research. But I've had quite a few arsey conversations with paper printers who say its ridiculous I can't believe you want RGB I'll have to convert it
[14.40]
But its actually better
Becky: Yeah because you're discarding colours that you might be able to achieve just by going CMYK
Solii: So theres some quite entertaining conversations where you're like am I going mad? Do I know what I'm talking about? And start questioning yourself because these are good graphic designers but yeah then they're like I'm really sorry and you're like ok fair enough. So yes definitely RGB. Not a specific one
[15.10]
I've done lots of research and apparently RGB 8 is the standard one that Photoshop tends to give you but you can 16 or 4 I think is the other but 8 is the pretty standard. I don't think when you've got a variable of steam and all of the other variables you can go too specific so you can think about it too much. Again I've had a few clients and not even clients, my business partner, you've have to not lower your expectations but just be a bit more flexible because you can't pinpoint accurately print so much because paper printing is so much further forward in advancement. Because there's limited chemicals sitting in there and you're not steaming paper
[16.09]
Becky: And you don't tend to rub paper or drape it or fold it or cut it up
Solii: And its not got gaps in it

[16.23]
You can't see through it generally. Gee we'd have people who'd say your chiffon or habotai the depth of colour isn't as good. And you'd be like yeah can you see your hand through it because there is gaps in fabric, therefore there is only so much substrate that holds ink so yeah the depth is always going to be the problem.
[16.59]
What we did say if you because and part of the other issue is because screens are backlit you would have people most people in textiles or graphic design use apple products and their screens seem to be more brightly back lit. very few people use a matt screen because they're very expensive very few people have them colour calibrated so that's those are issues as well so they'd be saying well its not the same as what I see on screen and you'd be like well fabric absorbs light your screen is back lit so its shining light out of it
[17.37]
what I would say if you wanted to match your screen then raise it the vibrancy of it, and oddly it's the vibrancy in photoshops tools that very few people use its something I came across almost by accident several years ago and then it was like aha
[17.55]
and basically what that does is your colour picker, if you imagine your colour picker in photoshop, if you raise the vibrancy on it it effectively saturates, well no its not saturation, intensity of colour is on the right hand side as you're looking at it does that make sense. By adding vibrancy and its not a percentage upping that you do but the maximum is plus 100 so if you want to add depth of colour I would always say to people if you add plus, try plus 100 try plus 200
[18.38]
but if you can that colour all the way over to the edge, I'm pointing but you can't see me (laughs) but not necessarily the corner but the far right hand side then that's the most colour that you can lay down which means that you're getting more ink which means that the steam is more likely to fix that colour harder and it will wash out less, because also you give it a wash process to remove any excess ink
[19.09]
so if you want that colour more of it so that's how you do that so yeah again there were those elements oh work to pantone book colours but you might want to, we were very keen to make sure people sampled
Becky: I was going to say did you recommend colour testing
[19.28]
Solii: Absolutely and not colour chip testing. Because again with colour science you put a blue or you think about putting a black and white next to each other and one seems darker than the other depending on which way that box is your brain messes with you
Becky: The Laws of contrast yeah
[19.51]
Solii: Yeah so if you just do colour chips and those colours in isolation you're not going to get a true representation of it similarly if you've got a really big pattern you want to sample a section of it not reduce it down to twenty centimetres because again the colour will change slightly because there's not as much of it because its smaller proportion of it so again theres loads of things you have and I often felt I sounded like a complete loony and utter crazy person saying 'you can't do colour chip because it will effect the colour, yes I know it's the same colour but its not and don't change the scale of your pattern because that changes the colour even though they are the same colours but they're not

[20.42]
so its colour is a nightmare.
Becky: It is a nightmare, its really subjective
Solii: Its really interesting so
Becky: I think that I might just write that as the thesis that this cannot be solved
[20.57]
Solii: Absolutlely I think so that was the thing so both my sister and I are kind of perfectionists, we're really irritating.
Becky: So that was a really challenging industry for you to be in then
Solii: really really challenging. We had to sit down and say you know we can't solve this. This is not something that can be solved. There is a variable that we have to become comfortable with. Which once you get to that stage you have to be like ok that's fine we can't control it. Then something else happens and the steamer doesn't quite do its thing and you're like no! Why!
[21.31]
Yeah so I think again because my, some peoples see colour detail, and I saw it more because I was working a lot more than Zoe so I would be like 'Oh do you think they look the same' and I'd know they don't and she'd be like yeah same colour its just a different shade. And I'd be like its not the same colour. And she'd be like it's the same colour its just lighter. But that's different.
[22.05]
Becky: So did you have a colour, obviously because you didn't go for colour chips you didn't recommend a colour chart because I've come across lots of things on Spoonflower or Contrado where they're recommending download our colour chart or have our colour chart printed on your fabric and then you can match the RGB values to your design and then you'll know your colour will be ok.
[22.27]
Solii: That's just I think also both contrado and spoonflower use dye sublimation so they're not steaming so they do have a little bit more reliable colour when you get your fabric. Wash it three times and you're screwed cos its washed out or five. But they have the ability to reliably reproduce type of printing they're doing but that reliability degrades quickly because of the type of printing so what you gain in one side you take away in the other because with reactive printing in theory you're creating for longevity which is the other way round when it comes to dye sub.
[23.25]
Becky: Ok let me have a quick look through my questions make sure I've covered everything Oh did you ever use a specific rendering intent or did your profile, your computer software just chose that for you?
Solii: Our computer software chose that for us. And we invested in that because simply it would be too time consuming to look at each file and think about it
Becky: Were you using AVA?
Solii: No we were using what print server 7
Becky: Is that [Redacted DPB B]
Solii: No its an Italan company actually but it was through SPG or Stork Prints
Becky: They're the people who started it all off really
Solii: Yeah they're lovely.
Becky: So they're your dutch people
Solii: Yes
Becky: Ok lovely I think that is everything that I wanted to ask you Solii and I also wanted to say thank you because I've really enjoyed following you on Instagram with your print Wednesdays

and everything its just been really nice to see all the digital printing in action and so forth so I wish you all the best with what ever you decide to do in the future
Solii: I'm off to go and do creative things for myself and actually make clothes for myself and my friend and I have started doing mural painting so we're going to do some of that and I'm going to start a very boring business because I'm basically unemployable, in property which is my other passion.
Becky: Oh exciting. Lots of fingers in lots of pies
Solii: Yes I know I don't like being bored.
[25.28]
general conversation and good byes

BlackPop – Design Studio

Interviewee: Maxine Hall from BlackPop
Interviewer: Becky Gooby
Date of Interview: 13th July 2017
Method of Interview: Audio Call
Consent given: Yes
Transcript approved: Yes
Recording in Maxine Hall.WMA

Duration 40 minutes

Summary

Maxine outlined how they adjusted their designs depending on the intended substrate. [3.40] They design primarily in Photoshop and print with a bureau predominantly on British Velvet using water based dyes / inks. [6.03] She was unsure if these were reactive or pigment. She has a background in reprographics and photographic printing and therefore has a comprehensive knowledge of digital colour and colour conversion to CMYK printing. [10.48] She has a good relationship with her bureau and requested details about their profiles so that she could assign them to her images[15.40] [18.10] She believes that having commercial experience is the best way to gain technical skills and wouldn't expect universities to teach this to students [18.10] They reduce their variables by printing primarily on velvet but occasionally print on silk or offer other fabrics if clients request them [22.33]

About BlackPop

I came across BlackPop at Decorex 2015 trade show. They have since collaborated with the Soane museum but at the time were exhibiting a range of fabrics inspired by portraits of tudor kings and queens. They do a lot of contract work with hotels and restaurants. Their website says "Blackpop is an independent British label specialising in designing elegantly distressed wallpaper, fabric and upholstered furniture for the luxury market. Manufactured in the UK, Blackpop is proud of its artisan heritage and its roots in the heart of the Derbyshire Dales."

Websites

https://www.instagram.com/blackpopuk/
https://www.blackpop.co.uk/

Becky: I saw your designs at Decorex back in 2015 and was really inspired by how well they seem to accommodate digital print as a medium but also pretty impressed that you were using velvet because it's a fabric that I've always had problems printing upon digitally and I was just wondering whether you'd ever had any issues with colour consistency or problems with sourcing the appropriate treated fabrics for printing upon
Maxine: So can I just ask in what capacity have you been trying to print on for your research or when you're making your own designs
Becky: So I started out as a textile designer in 2008, designing fabric for upholstery and mainly making bespoke pieces so that the fabric were designed specifically for that item of furniture generally tending to be based around the memories of the person who owned that item and I was using [Redacted DPB E] as my digital printers who were in Tower Bridge and discovering that if I printed on linen I would get completely different colours to when I printed on silk and so

started to investigate what was going on here. I'd had some idea in my head that digital print was not magic but it was I'd kind of could get what I saw on the screen printed on the fabric and that was never quite right so having spoken to other freelance designers who were also having issues I began the PhD back in 2015 just looking at the different variables involved that affect colour and I'm trying to generate an online resource sort of a website which will have information about the process for designers and small businesses who might not have access to really high tech colour calibration kits to control the colour through out the process so that they have a bit more of an idea about how the colours will be, how to achieve the colours that they are expecting.
Maxine: Well of course we have the same problems, it does vary widely according to the surface or material that is printed onto so for instance if we were printing onto linen we would realise the colour is absorbed much more and we would get a much more faded outcome and we would allow for that within the digital process. Regarding the velvet, I'm

not quite sure, so with the velvet if what you're talking about having designs that go on wallpaper and trying to match that, when we print on wallpaper I mean sorry velvet everything comes up a little bit more punchy a little bit warmer and so just through kind of trials we've learnt to accommodate those differences and make allowances for them when we're preparing our digital files.
[3.40]
Becky: Ok so you make adjustments in the software that you are using. Do you mind me asking what you design in, do you design in Photoshop or Illustrator.
Maxine: Yes Photoshop, well it's a number of programs but they're all brought together in Photoshop.
Becky: You don't use AVA, because I know some of the big, sort of like Mulberry and Liberty use it because it's, its quite expensive
Maxine: No
Becky: Ok and so the reasons that I've heard that velvet can be problematic is because its obviously got a pile to it and it tends to create a fluff on the print head so you sometimes get sort of blobs of colour or patches that aren't quite printed or the colour doesn't go right down to the bottom of the fibre. Have you had issues with that yourselves?
Maxine: No I haven't we only use British Velvet theres quite a lot of different Velvets, which is pure 90% cotton so I don't know if that makes a difference but certainly the British Velvet has a much softer feel to it whether that affects the print heads I don't know whether other certainly at the edges like any velvet you lose lots of bits because it frays really easily doesn't it. No we haven't had trouble with that. I think any digital print isn't going to go right through like a dye will so that's one of the down sides particularly if you're using a darker colour but if you're bending it say through some pleated deep buttoned recesses or something you know we would see a whiteish line it doesn't go right through the velvet so it limits what we can do upholstery wise with the velvet only the velvet.
Becky: And do you do the printing in house or do you out source it?
Maxine: No we outsource it locally.
[6.03]
Becky: And would you mind telling me who your printers were?
Maxine: Again I wouldn't want to say that I know they're not taking on any more clients. So
Becky: Do you know if they, do you know what kind of dyes or inks that they use. Do you know if its reactive or pigments?

Maxine: I know that they don't contain any formaldehyde so they're environmentally friendly, they're water based I think they're pigment based but I'm not sure about the pigment but they're water based
Becky: And how do you tend to choose your colour palettes are you inspired by things around you do you scan colours in or does it all start off digitally or do you start by hand and scan that in, how do you tend to work?
Maxine: Different ways really, sometimes I'm painting and dripping paint onto paper or canvas and then scanning that in. Sometimes I'm creating graphics in Illustrator and I'm using the Pantone Colour charts. And other times I'm being influenced I think it was possibly

the tudors at decorex, fabrics that you saw at decorex they were completely guided by the colour pigments in the portraits that I was working from. And I don't know if you, I was given an amazing bank of digital images that had been taken through microscopes by Bank of America did some investigation into those portraits so I had about 100 very high digital very high res digital images to work from so for the colours I didn't go outside of that palette.
[8.27]
My background when I left uni I think in about 1989 something like that I was introduced to Photoshop 1 and I was the first student at Westminster University to specialise in digital photography so I've had a long time, many years of practice and experience from university I went into Tapestry which is a high end reprographics company in Soho and I was working with them as an artist to experiment with digital output and try and push the boundaries of digital output so it was there that I learnt all about the control of colour and how to, so for instance when I'm using colour in Photoshop I can I know for instance that the white in order for a white to print it can't be zero Cyan, Magenta and Yellow or zero Red, Green and Blue because there will be nothing there so I know it needs to be up to about 11% of ink so its like 6/4/4, 6 Cyan or Magenta etc so when I'm working on my images, adjusting through the mid tones and shadows like that in a way. So a lot of it isn't left to chance because I can through the logarithms and histograms I can control the colours you know that I'm hoping to achieve and as far as the rest of its concerned you know we all have colours that come in and out of favour in our heads don't we so for the new collection I've just done which is Birdland which will be launched at Decorex this year I just used the colours that I was into
[10.48]
Becky: Wow so you're bringing an awful lot of experience and knowledge to your colour choices and in a way that actually no other designer I've spoken to before has because most people are saying that they sense the colour or they get a feeling for colour where it sounds like you have a bit more of an idea of the digital make up of the colour and therefore can control it more that's really interesting to hear. Because one of the things I've been doing is looking at the Pantone colours and printing them out onto different substrates to produce a colour reference book that people can look at so they can see ok so a red on wool might come out differently to a red on linen and most people have said that that would be useful because visually they could get that and they've been less keen on things that deal with the numbers and the statistics behind the colour it would be less helpful for them but it sounds like it has been useful for you because you've become accustomed to it and worked for a long time with it
[11.56]
Maxine: Yeah I think so I mean outputting onto material is fairly new to me because I've been doing that for four or five years now but the thing with anything isn't it if you have a little confidence and experience in the rules of the digital then it allows you that confidence and kind of expertise allows you to work with more creative freedom.

Becky: No that's very true I agree. Are there any colours that you tend to avoid Maxine because you think ooh gosh I know that that's a bit tricky or its not got very good

lightfastness say, it wont stand up to commercial testing or you know that they're tricky to print on
Maxine: Well I know that you can't achieve its different isn't it photographically, photographic prints you can't achieve hundreds if not millions of colours because they're out of the spectrums of the printers. But I found that with the fabrics you've got a much wider palette to work with whereas photographically some of the popping oranges will not be possible but on fabric it is. The printers work differently because of the input within them but so I haven't found on fabrics I haven't found many limitations so it just comes down to taste I think and you know whether I think they're workable but when I'm designing, I think I'm designing probably for very niche audience, and possibly quite a commercial audience because what you can get away with in a home you can push boundaries in hotels or in offices or in restaurants in clubs can't you and homes unless you're brave and pretty avant garde you're kind of not brave enough to create and live with certain colours so but I'd like to see myself as more of an artist, a commercial artist than a designer, so I tend to kind of I'm happy to have a smaller output or a smaller clientele but be able to make designs that I think are kind of pushing the boundaries a bit.
[15.08]
Becky: So to get the job satisfaction rather than churning out bog standard designs
Maxine: Yeah, you've got to have some fulfilment
Becky: Oh exactly, yes I totally agree. Do your printers recommend that you use a particular colour profile, embedding a colour profile into your designs do they provide you with one?
Maxine: Yes. Its always really important to match your profile with whichever printer you're using
[15.40]
Becky: And did you when you went into partnership with them did they talk to you about that or was that something you brought up?
Maxine: I brought that up, I've just asked which colour profile they'd prefer
Becky: Because I was asking because most of the digital print bureaus I am reviewing don't seem to suggest that whereas I know for graphic designers that is much more industry standard that you ask for the profile or the profile is given to you and so I was just querying with digital print bureaus why they don't
Maxine: Well that's interesting.

Becky: It seems to be that a lot of people don't want to reveal their profile because they feel that it shows the limit of colours that they can achieve, or they worry it will look very different on the persons screen at home because they can't control they don't know how their screen has been calibrated or they can't control how the person is viewing it
Maxine: So what would they, how would they submit a digital file to them if you're not going to embed the same profile?
Becky: Well that's exactly that's what I think but I think a lot of people tend to use the two the Adobe 1998 RGB profile which has quite a wide colour gamut or the working sRGB profiles which are kind of quite standard but they both have got wider colour gamuts than the profile that the printer would provide so you'd still get some inconsistencies but as

you've already told me you don't tend to get colour issues it sounds like having that profile is a really key part of that to make sure that the print environment is all sort of talking to each other properly, technical term
Maxine: If the printer is not going to let you have the design of the printer and they're not going to share their profile with you I wouldn't use them because like you say you don't know what you're going to get at the end of it.
Becky: But what I'm finding and this is how I started off I had no idea about any of those things I didn't know to ask and because the information wasn't forthcoming I think its almost a lack of education of designers because its not being taught at university or people have been out of education and working in industry and therefore digital print wasn't around when they were at university
[18.10]
Maxine: I think as well I mean I was a lecturer for a long time when I was uni was pretty early on but I get the feeling that really if you've got if you want to get a good experience of the digital environment you've got to go out and work in a commercial sector I don't think university is going to give you that amount of detail technically because you know there's this mixture of the thinking behind and the meanings and all that and so I wouldn't really almost expect students to come out with that sort of knowledge they're lucky if they do you've got to really after you leave uni you need the work experience
Becky: Yeah go off and do internships
Maxine: Well go and work for someone for a year
Becky: or get paid
Maxine: If they're interns they're not going to find that experience anyway you've got to be in there haven't you working with the team
Becky: Are there any designers who inspired you, I recently spoke to Duncan Neil at William Clark and one of the first people he said who he thinks are using digital print really well are yourselves and I think his designs are really exciting the stuff that he has produced for William Clark but is there anybody who you think is using digital print well or colour particularly well in digital print?
Maxine: Well I kind of look at fashion and see the digital print there I mean I'm a big admirer of Vivienne Westwood because I like the way that she brings histories together and re-works them so that's what one of the process in which she works theoretically and creatively I'm really inspired by that. And the digital print that's coming out that now the fashion houses are using on velvets and silks etc etc all of them I'm thinking of I mean I'm also a big admirer of timorous beasties I think that they gave me the confidence to do my own thing I think they've been really brave and sort of shining a light for people haven't they. I was really taken with where was it Paris Wakefield, I think we started off in the same year, 2013 and they were at Tent as well but I remember walking round and seeing their designs and I thought wow they're good. I think, Jessica Zoob, working with black edition (https://www.blackedition.com/collections/desire-by-jessica-zoob) I liked her painterly velvets and fabrics. I like people who are brave and push boundaries.
[22.33]

Becky: Yeah because I think especially in the interiors market as you say a lot of inspiration a lot of people who are using digital prints seem to be in fashion because you can produce short runs and you can be a bit more adventurous respond to your market quite quickly whereas somebody in their home they're not going to be replacing, reupholstering or redecorating so frequently but it was really interesting when I do go to Decorex seeing that there is an awful lot

of samey samey more muted colours but I like you, tend to be drawn to people who are being a bit more out there I suppose
Let me just have a quick look because I don't want to take up too much of your time Maxine. Do you think you'll ever, because at the moment am I right you are printing entirely on velvet or are you using any other substrate, apart from the wallpapers?
Maxine: We do from time to time work with silk quite a bit just done some silk notebooks and we're doing silk scarves I think because we're quite a small company to offer too many variables gets expensive, although we do kind of offer them as a bespoke thing but yeah we're not we don't sort of have pattern books of silk we just keep to the velvet we have a really nice relationship with our clients and obviously if they like a design and they want it on linen or silk or cotton then we can do that
Becky: Would you do that with the same printers or would you go to someone like the [Redacted DPB A] because its silk
Maxine: no we do everything in house with our printers
Becky: There was at TexFusion which did have a small home and interiors section but it was primarily aimed at fashion there was a company called Think Positive have you heard for them they're Australian but they have just recently come to the UK market but they are I suppose they're selling stock designs but they are also a digital print bureau but they've developed a way of printing so you do get a show through on some silks and more sheer cottons so that was quite nice for looking at for thinking at things like scarves
Maxine: I think most print people will do that. If the silk or fabric that shows through not the printing
Becky: But for some reason they could get the colours looking bright on both sides without it seeming like you could tell which side was the printed side
Maxine: I have had some samples from them and yeah they're good but for me I started off with these printers the people I use and there is a loyalty there so I think its really important to build up a relationship. I'm just searching now for Think Positives prints, yeah I think they've been round a couple of times. I imagine that it's such a growing market isn't it I mean you can now just send off your designs and get them put on almost any substrate can't you just on line. Its really changing
Becky: There's a company called RedBubble who are again US and Australian based but you as a designer have your own profile and you upload your designs and then somebody can choose what they want to print them on so you can print them on leggings or duvets or mobile phone covers so yeah its
Maxine: Let me just drop them down, because I've been trying to find, you can't get duvets done in this country
Becky: Its really tough isn't it

Maxine: Its really difficult because of the widths of them is difficult for the printers or something
Becky: I spoke with their quality control manager so they have different printers depending on the item that they're printing upon and she really struggles to get colour consistency between the items because they are different materials and she spends her time going, flying across America and Australia going to different printers to check that they're matching up the colours
Maxine: Sounds like a nightmare
Becky: I know! I don't want her job. She is based in San Francisco which seemed like quite a cool place to be.
Maxine: What were they called?

Becky: Redbubble, I think they're primarily, graphic designers who are uploading their work and that's what I've found that it does seem to be people with a graphics design background who are digitally printing onto textile and textile designers seem to still be the majority still seem to be frightened, I don't know whether frightened is the right word, they don't get the same, there is something a lovely quality to silk screen prints I suppose that people are very devoted to and I totally see why. So yes but it did seem to be graphic designers who are utilising it. Yeah have a look there is a whole wealth of things and I'm sure if you contacted them they might tell you who their duvet printers are.
Maxine: You can always try
Becky: Do you think you'd be able to tell the difference between a digitally printed and a mechanically, traditionally roller-ed or silk screened fabric,
Maxine: I think only from the design. I think you can tell if the design has been designed digitally or if its silk screened. Because the silk screen I think its always going to have a plain background and you know more block colours. I think only through the content not thorugh anything else. Why what do you think?
Becky: Its because a lot of, what's surprised me how small a percentage of the market digital print is and theres a lot of designs out there I had thought might be digitally printed but obviously aren't because they must be, maybe they're dye sublimation or I'm just not reading the designs very well but yes I agree I think looking, there are certain designs that you think that can't it is impossible to print it any other way than digitally
[29.47]
But I do also think a lot of people use digital print to recreate prints that could be silk screen printed so they do have that blocky style but perhaps because they don't want to have to do the larger print runs to make it economically viable.
Maxine: I mean with digital print its just to have a small run its cheaper isn't it in the long run its cheaper to do the other way because it never goes very cheap like it did when we were using the rollers and things
Becky: Although I know that a lot of people are looking towards Italy or Thailand to get much cheaper digital prints just because the costs are lower there compared to using UK printers but then you lose that lack of control and being able to go to the business and talk to the printers so perhaps its not as easy a relationship to have them so tricky

Maxine: And its not only the control its I don't know its that I mean I know one I'm not a kind of I wish we weren't going through Brexit I'm not anti using other people but I do think for us its nice to support local companies and support them rather than get it done elsewhere of course you could do that but if everybody did that we wouldn't have an industry here
Becky: Yeah I think particularly talking about people, your clients, its nice to have that backstory you can say its British Velvet and its printed locally or it becomes very it has become more and more important to customers I feel
Maxine: If they can afford it, that's the problem it makes everything very expensive it's a difficult choice isn't it to support your local company and then make it more expensive for your clients or to just sell out.
Becky: But I think with interior fabrics people do tend to pay a little bit more because they want to get longer lasting, better quality, but yeah it's a really tough one because you can go to Ikea and get very cheap brightly coloured fabrics very easily so yeah.
Maxine: I've been working doing quite a lot of experimentation printing onto china and I think that that industry hasn't' really got the quality as digital print yet they still can't produce the colours that say for instance you can get onto fabrics so I think that's still developing.

Becky: I went to see at the Design Museum in Kensington, I don't know if you've had a chance to see it the Hella Jongerius and she's been experimenting with metal oxides on pots where you can't control or predict the colour and the colours are just beautiful really really stunning and she's been really investigating traditional pigments and colours so it was really nice to see that history and making sure people hang on to the knowledge and take it through to more modern methods. Yeah fantastic show I'd really recommend it
Maxine: We can't afford that element of surprise though can we
Becky: No! Surprise your chair doesn't match your curtains. But yes oh Maxine thank you so much for speaking to me I really really appreciate it
Maxine: You're welcome
Becky: I'm trying to build up a picture of how designers are working and engaging with the process so that can then help me work out what the best way to sort of what the best direction to go for for looking at methods to help people or to put together this online resource which would suggest things that designers could learn about or use to help them so its really generous of you to speak to me thank you. To avoid me having to make notes I've made a recording of the conversation which I will transcribe would you like me to send you a copy of the transcript
Maxine: Oh Ok then
Becky: I'm very happy to do that. And what I'm doing is I'm working towards a thesis publication and a book as well about digital textile printing so if youre happy for me to reference Blackpop in that I would love to but obviously if you'd prefer to stay anonymous then that's fine too
Maxine: Yeah that would be great. And some images would be fab

Becky: Yes that would be great thank you very much so I'll get working on the transcription and send it to you in a couple of weeks it takes me a long time
Maxine: Oh well don't do that especially for me
Becky: No I do that especially for me so you'd be getting a copy as well but I do it for me.
Maxine: Alright Becky well good luck with everything
Becky: Thank you so much and have a lovely weekend Maxine and lovely to speak to you
Maxine: Cheers you too
Becky: Cheers, Bye.

Earthed Fabrics – Design Studio and Textile Mill

Interviewee: Duncan Neil from Earthed Fabrics, William Clark
Interviewer: Becky Gooby
Date of Interview: 23rd May 2017
Method of Interview: Audio Call
Consent given: Yes
Transcript approved: Yes
Recording in duncan neil.WMA

Summary
Duncan first engaged with DTP at university where he was printing photographic work. He was really pleased with how the photographs were printed onto fabric despite the process being slow because these were early machines. He was using 'loud' colours and didn't find that there were colour matching issues. [2.54] He thinks that this might have been because the nature of the photographs, which were very colourful, disguised, any discrepancies. After graduating Duncan worked at [Redacted DPB D] (the commercial print bureau at Glasgow School of Art) and then [Redacted DPB C], a fabric printing company (https://turnbull-design.com/) where he gained further experience of DTP. At [REDACTED DPB D]they had Stork DTPs and at [Redacted DPB C] they had a Polaris. These machines were more up to date models than the Mimaki he'd used at university and were faster and better quality. [7.35] Currently Duncan is using a D Gen Arachne with an AVA RIP. He has had issues with running AVA on a PC which doesn't give him full access to all the RIP tools which is frustrating. He rates AVA as a piece of textile design software and for its colour tools and capabilities despite its expense. [10.06] In his experience colour issues are not due to the printer, apart from maintenance issues such as clogged nozzles, or colour management [12.08]. Instead Duncan identifies substrate, and in particular the pre and post processing it undergoes as the part most likely to affect the colour outcome. [12.08] [14.09] At Earthed they print predominantly on linen, which is the cloth created by William Clark, a linen mill. This means that he has control over how the fibres are treated from start to finish and has been able to get a bespoke coating mix made for DTP. The prints are made with reactive dyes which require post processing for fixation. [14.45] Whilst the area the DTP suite is housed is modern and controllable, the steaming and coating areas are in the older mill buildings where temperature and humidity are difficult to control. He has done a lot of work on getting the chemistry correct to enhance the printed colour but knows that if there is a colour issue that he should generally check the coating or steaming first to rectify. [16.29] Duncan starts with colour testing for all new batches [17.55]. This incorporates profiling and paying attention to the substrate white to ensure that the profile is set up correctly. He notes that Photoshop can create a false impression as the white point is always too bright, by about 10% in comparison to the whiteness of the cloth. At [Redacted DPB C] he would use a particular design as a test artwork which he would use to colour test. He finds greys in particular are very problematic which whilst he'd like to avoid using them is a challenge because they are very popular and also cream because the dot matrix / dither is often perceptible although there are tools you can use to avoid this in AVA [20.21]. He assess colour visuall / by eye rather than using the delta E colour difference because he finds that this is the most accurate method and has

experienced issues where a colour was shown to be in the tolerance but did not look correct. [21.52] He sometimes uses Pantone (chips and digital) but doesn't think it is very accurate. He will use a spectrophotometer to measure colours but will generally take time to get a colour right by altering the depth or brightness. [23.57] He acknowledges consistency as an issue again with greys and says that the development of textile chemistry is improving things such as lightfastness. Duncan noted that the aesthetics of digital textile design can be used to disguise colour issues for example not printing areas of flat colour which would be better suited to screen printing. By including things like 'tonal movement' and a large range of colours you can disguise colours being 'off'. Duncan continues to use photography as an inspiration and this also inspires his colour palettes or colour themes [29.05] He rates many designers who are creating designs especially for digital print but says that there are issues with people using digital print as the 'easy' option or using digital print to print out old screen printed designs which don't necessarily suit this different medium. Designs that work best are those that have a high colour count and play with scale as well as having 'tonal movement'. His preference is for reactive dyes although he has experimented with pigment prints but found the fastness quality poor [33.00] He is keen to follow developments with VAT dyes for DTP. Similarly his preference is for natural fibres, which fits the business model working with William Clark who can produce their own linen. [34.18] He appreciates the flexibility of DTP (short print runs, print to order etc). [37.22] He finds that AVA colour management is pretty accurate and builds profiles using their software but has experienced issues with profiling in Photoshop[41.22]. He recommends working in RGB. He would expect that design students would gain experience of profiling etc in industry rather at university. [41.22]. He suggested that a DPB might be hesitant to provide a profile to their customer because it would reveal the colour limitations although it might also provide a more realistic expectation. [44.47] Duncan felt that there is a gap in knowledge when it comes to understanding colour management particularly due to changes in education and industry so that is has become difficult for designers to gain an understanding of such processes and practices. He sees this as a big problem for digital print and said that despite having the experience he has he found understanding the language and terminology at SDC (Society of dyers and colourists) challenging. [44.47] He felt that colour tutorials for students via the toolkit could be helpful especially for artwork that is separated in layers (different colours per layer) but also felt that having an understanding of the adjustments that a designer can make using colour tools in software would be of use as well. [44.47] He spoke about the differences between the two main virtual device profiles Adobe 1998 RGB and sRGB, feeling that sRGB, a monitor profile, gave a false impression in comparison to Adobe RGB. His preference is to work in Adobe 1998 RGB. He recommends designers find a profile that works well for their printing environment (with a DPB), that they should invest in a kit that will calibrate their monitor and proof by printing onto paper [51.23] He received good CAD training at university and says that this plus an understanding of colour tools in design software through practice and trial and error has helped him get a good understanding of balance and colour contrast. [53.55] Recent issues with pale colours have provided challenges but having control of the base cloth has been helpful, and he colour corrects by doing lots of colour measuring, profiling and checking the textile chemistry. He has seen some great results through printing onto viscose but he thinks that the Irish linen he uses is a great substrate to work with because of its quality and the ability to control it from plant to fibre to cloth. [53.55]

About Earthed Fabrics

Earthed Fabrics are the creative operation of William Clark, a linen mill. They produce digitally printed interior fabrics. The Creative Director is Duncan Neil. As a mill they grow and produce their own linen which is then printed upon. Their website says *"Earthed creates contemporary luxury interior fabrics printed on Irish linen. We use vivid colour and pattern prints for soft furnishing purposes and produce high-end luxury accessorises such as cushions, lampshades and decorative fabrics for home interiors. Our award-winning designs are inspired by the wonder of nature and printed in the UK for quality."*

Websites

https://www.instagram.com/earthedirishlinen/
https://earthedbywmclark.co.uk/
http://www.wmclark.co.uk/

Becky: Thank you for agreeing to speak to me, I don't know whether Phil managed to explain but I'm doing a bit of work with Phil Henry at the moment but it was actually Trish Belford who suggested that I speak to you cos she'd heard you speak at the Society of Dyers and Colourists?
Duncan: Yup ok
Becky: Particularly about colour and digital textile printing and I have been working as a freelance textile designer since 2009 mainly in digital print and kept coming across this issue where I'd send files away and they'd come back and I'd be like oh that's not quite the colours I was expecting but perhaps that's my fault and then speaking to other designers and they were facing similar issues which was why I decided to apply to do the PhD and now a year and a half down the line I'm sort of beginning to realise that it is sort of a, its much of a bigger issue then perhaps I'd envisaged and I'm now trying to put together a tool kit that designers can access so that other people can understand the controls they might need to put in place if they want to get their colours right.
Duncan: Oke doke. Yeah I had a quick read of your document so
Becky: Yeah I hope it makes sense, its now a year old, so I probably need to revisit it. But yes so I've been looking into your own practice and the work that you've been doing at William Clark and its saying, I mean obviously, you're multi skilled and its not just digital print that you specialise in but I was intrigued, they've got an interview with you on the William Clark website where it said you started experimenting with the digital textile printing back at university in Dundee, and I was just sort of wondering whether you could tell me a bit more about how your style or what experiences you had with that back in the beginning of your career 2003/2004 [2.54]
Duncan: Ok yeah that was some time ago now, sadly. When they installed a digital printer in Dundee during my final year, I was doing a lot of photographic work, so just timing wise it was perfect for the work I was doing. I was working with polaroid photographs so being able to reproduce them on cloth was fantastic. I mean back then it was very slow. I think it was about a metre an hour possibly maybe a little bit more. It was very slow. At that point for me everything the everything was very loud what I was doing so I don't recall having any major colour issues going from paper to fabric at that point in time. But basically it was tartans I was making out of polaroid photos so it was loads of colours so if that hadn't had been perfect you might not have noticed so quickly. I mean I'm pretty sure probably a lot of, it sounds like you're practicing yourself as a designer and working with digital print I'm sure a lot of the things I've learnt over the years you're already aware of to be honest but back then I can't really remember any huge massive issues I just remember it being very very slow.
Becky: What was the make of printer do you remember do you know

Duncan: Yeah it was a Mimaki Tx1600
Becky: At UWE we've got a Mimaki TX200 so probably not much
Duncan: I always get confused with Mimaki names to be honest I think the TX200 was out after the 1600,
Becky: But still fairly elderly I think
Duncan: it is but the TX200 is a lovely machine its really nice. Yeah I mean I've worked with a few machines now and that would, TX200 ranks second of my favourites that I've worked with so far
Becky: That's interesting. I like the fact that you've rated them. Because you've worked at [REDACTED DPB D]and at [REDACTED DPB Y] prints as well. So were you the technician there responsible for the machine or were you more doing design work?
Duncan: No basically when I was at [REDACTED DPB D]I was there on a kind of temporary basis. I'd left my job in London and moved back to Glasgow and at that point in time they were just thinking about starting work placements so they kind of took me on for a few days a week and so essentially it moved from printing to processing the fabric, sampling to set up and those kind of things. It was two Tx2s, they were Stork machines, but Mimakis really. They were around at the time. And s, and then in Turnbull's it was a completely kettle of fish it was a much larger machine, it was a Polaris so completely different end of the spectrum in terms of scale and 1. size and 2. volume that it was capable of outputting and the number of heads etc so yeah I think its for me its always interesting to see how digital print progresses. I mean you know yourself there is so much involved in it and its interesting, the machine I'm working with now is probably my favourite machine that I've ever had which is the DGen Arachne Hexa its just size wise it's a really having come from the Polaris which obviously was really large, it's a really nice size its not much bigger than a Tx2 really but its got an output, well depending on what resolution you're printing, up to about 36 linear metres an hour so for a small machine its pretty speedy. There's an ease with working with it, everything is really done back end of the computer so in terms of operation whoever is running the machine they've obviously got to just thread the machine set it up do regular cleaning but in terms of the operation its pretty smooth.
[7.35]
Becky: Its running with AVA as its RIP or has it got its own software?
Duncan: It does yes, it runs with AVA
Becky: We went to FESPA last week no week before, myself and my supervisor, and Caldera was the RIP that most of the textile printers were running which was interesting because I'd only known of them as paper RIPS
Duncan: Yeah I think one of the issues for AVA pretty much all printers run off PCs so that the kind of big stumbling block for AVA. I know at first they were kind of unsure if they could get this to work but the slightly newer model of the Arachne which is I can't remember the name of it but there was no issue with it working off an AVA RIP but it took a while to get this going effectively at the beginning, I mean there's flaws to it in terms of if I was running it off a PC I'd have access to a lot more information than I can when I'm running AVA through the Mac because I don't know if you've seen the AVA RIP have you?
Becky: Yeah we use AVA RIP for the Mimaki and have AVA come in and calibrate it and look after it.
Duncan: Yeah so I think to get that working on this machine there's no record on the machine of how many metres you're printing.
Duncan has to take a phone call so brief interlude in interview
[10.06]

Duncan: Yeah so AVA there's no record on the actual machine of how many metres has printed it does tell you the number of passes its going to take to complete the job so you know how many passes you'll print to do a metre so you can kind of work it out but that's the kind of downfall and I don't think the machine manufacturers have really embraced mac.
Becky: I hadn't even really considered that before, that's an additional variable to consider
Duncan: It is with AVA, you can get around it with the AVA. I love AVA I've worked with it now for 6 years and I completely love it. I love the software the colouring software I love the separation software but its hugely expensive and I wonder how anyone can really try and control things and AVA is not something for anyone it costs a lot of money but you can buy an extra additional plug in which I forget the name of it productivity manager that would log all the jobs and how long they've taken and if they stop part way when they stop and that kind of thing so you can get around it with AVA it just costs you
Becky: That would help with trouble shooting. Do you find you have many colour issues with the Arachne machine or is it?
Duncan: No I don't think colour issues are ever really down to, well not never, well overall I don't think colour issues are attributed to the machine unless you've got blocked nozzles or I think the colour issues tend to come further back down the line
[12.08]
so its such a big field I'm wondering where to start. For me most of the colour issues are likely to come from either the raw materials, your base cloth, or your processing, that's where I think the big colour variances are likely to come
Becky: And when you say the processing is that the secondary processing you're thinking of
Duncan: Yes, that would be the steaming and washing, its reactive dyes I work with so obviously they're steamed I'd say the washing is now its always difficult especially in this country and for us particularly we're an old company and a lot of our factories are quite old and quite open so really we have tight constraints on the conditions its really difficult. Where we're actually doing the digital printing is fine, it's a small room, its air conditioned, you can control the temperature, but get it out on the factory floor you don't have quite that control
Becky: Over humidity and so forth
Duncan: Yeah even just a breeze that's coming through the building, or is there a delivery at that time so the shutters are up, so to me its more difficult to keep consistency, it depends on your environment, environment is key. For me if something doesn't look right at the end I'd always be wondering about steaming first and then the wash as long as you're fairly consistent with your temperature and the chemicals you shouldn't really come into huge problems. Your huge pivotal part is going to be at the steaming part. But before that the actual cloth preparation, the cloth, the coating I'm very lucky here we do all of that side ourselves.
Becky: Ok so you don't buy pre-coated from Premier or Whaleys?
[14.09]
Duncan: No we buy the only cloth we use is from Ireland so we do the bleaching in house and singe it to remove the surface fibres and then from that we get it bleached and scoured to get rid of any impurities and then we do the coating application in house so at least we know all the way if we have done everything we should have done it should make it easier to print without a problem. Coating and steaming are probably the two areas that are most pivotal to the colour.
[14.45]
Becky: That's really interesting
Duncan: The steaming as well actually
Becky: That's really interesting you say that because I was speaking, well one of the chemists who I've been in contact with that's exactly what he said and I thought that's interesting that

you've identified your area of research as the key part but we've been doing coating experiments ourselves. Its really interesting to see the difference it makes to the colour and it wasn't something that I'd when I first set out looking at this had even considered before. But that's really interesting that you're re-affirming that
[15.28]
Duncan: I can't stress that enough to be honest. The chemistry is so important. We work with a chemical partner and they've actually been very helpful. At the point where we were just setting out the second quarter of last year we were looking at a few different chemical companies for the prep and there was just one that was night and day ahead of the rest. The rest were saying that our coverage prep wasn't good enough and that's why we weren't getting good coverage on the cloth. We had chemistry from another supplier that was giving us brilliant results really nice even colour. So I mean that's the first thing, if you don't have the chemistry on the cloth then you're kind of scuppered to start with for getting the depth of colour. I suppose the problem is when you're just buying, you're going via, a bureau printing service you don't know where they're getting the cloth from or if you're just buying in pre-coated cloth then you're completely reliant on the chemistry that your supplier uses. So its difficult.
[16.29]
Becky: So its really great that they can do it all in house. Is there any other, sort of, if you get the chemistry right, are there any other colour management or colour control that you tend to put in place or using your experience along the way that you feel are really vital for this colour criticalness?
Duncan: I think obviously the key thing is whenever you've got a batch of cloth, a new batch of cloth, just rather than printing things obviously colour test them first. I haven't since I've been here I haven't run into an issue where I've had a new batch of cloth and felt the need to put a new ink setting or something like that. I have had in the past and that could be down to, there are so many variances that could have an affect, it could be maybe the bleaching of the cloth was more brutal or less brutal, I'd say especially on linen the bleaching of the cloth is a big one. I'm probably going to jump all over the place in terms of where we are with topics, sorry, I mean the cloth in terms of getting a really good, getting close to what you expect to see on fabric from what you're seeing on the screen, one of the biggest issue is the white point on the computer.
[17.55]
Obviously working with AVA when you've got a profile you get your substrate white and that really does make a big impact to how you view things on screen because obviously when we look at things like designs in Photoshop that are pure black or bright white which doesn't exist in fabric so that I think is one of the biggest ones especially when you've got designs that have pale subtle tonal variations as soon as you move that on to cloth you're going to lose the first 10 % of it because your cloth is that bit darker. But yeah the key thing is just when it comes to checking colours and you get a new batch of cloth you've just got to run some checks make sure that you're ok sort of generally. I haven't run into much problems yet but when I was at Turnbulls basically we created a test file and ran it through all of the profiles for various cloths so when we got a new batch of cloth we scoured it coated it, we were buying in bleached cloth at that point so we just coated it, printed the test file on it and the test file would generally have a file in AVA which had 100 squares of different colours, generally ones we found quite problematic sometimes. And we'd print that and a couple of line detail tests and one or two designs on it that always seemed to be an issue.
Becky: Were there any particular colours or hues or tones that you found were most problematic

Duncan: Yeah I think greys are always a nightmare. And I think there's the reason for that is there is not, the quality of the dye in terms of blacks never black so it even tends to pull blue or green or possibly red I've found. Light to mid greys I think are particularly difficult. Creams can be very difficult as well. My biggest bugbear with cream is you can quite regularly see the dither build up, the dot laid down that makes the colour, which looks ugly. **Becky:** Speckly and noisy
[20.21]
Duncan: Yup. There are others I know AVA you can get to a certain extent get round it. In the RIP they've got that function do not print tones less than a certain percentage. But its amazing the difference, if you put in don't print tones that are less than 2% its amazing the difference that'll make to your colour. So I think a colour test is not a bad thing
Becky: And the test file, are you using a particular colour reference tool, like a Pantone, or is that something that's developed in house as well based on the collection at the time
Duncan: I'm certainly not doing it at the moment but when I was doing it at Turnbulls they it was the in house, it was all about the visual. It was really how well we see the colour and can we see the difference in the colour. I always think tolerance is a really grave subject. I remember talking to AVA and them saying that anything that came in the 2 delta E difference would be commercial tolerance. But sometimes 2delta E you can't see, sometimes 2 delta E is huge. Depending on the colour you're looking at. So with us it was always about how visually it looked.
[21.52]
Becky: Which makes sense as a designer.
Duncan: Well no the thing is you can tell your customer that what you've delivered is in 1.2 delta E of what they had last time but they don't really care its just about how it looks.
Becky: So have you ever used colour referencing tools or has it always been your own colour palette and your own eye that you rely on and based on your built up experience of repeating prints and looking at a red and going ah ok that's not printing quite right and going back to the design or?
Duncan: Generally, I think that a lot of it is toing and froing and testing colour. I have used, in conjunction with AVA I have used their pantone fashion and home collection and I have used it with customers as well in Photoshop. My main issue with using any kind of library to be honest is all down to 1 substrate and 2 how you get it, if someone sends me a pantone chip at least I've got something solid in hand, if someone sends me a pantone reference they've seen online I don't find it useful at all because I don't know what they're looking at how well their screen is calibrated. So to me I suppose there is a couple of ways you can get around it, if you bought a digital copy of the pantone library for example you can obviously print that out on cloth and have colour bibles which I have tried in the past but to be honest more often than not I think its more useful to just get chips. And quite often I would scan them in the spectrometer and that would be a starter point. Its not going to be the right colour first time but it kind of gets you in the right hue. And you might need to work on the brightness or the depth of the colour but
Becky: It gives you an indication
[23.57]
Duncan: Yeah a starter point yeah
Becky: And have you sort of consciously avoided particular colours ever because you think ooh I know that's going to be. Like I don't use light greys because I know that that wont print very well. Or I know that I'm going to be printing cotton so therefore I don't want to use these particularly really saturated colours
Duncan: It's a good question I think given half a chance I would probably avoid greys like the plague. However, they are one of the most commercial colours you can have so you can't afford

to ignore it. I think more so than, more so maybe than avoiding colours because of maybe finding them difficult to keep them consistent. I would say maybe in the past there would have been colours I maybe would have avoided because of the performance of the colour so you know the obvious ones is red, the lightfastness is quite bad, but things are changing all the time the chemistry is changing the dyes are changing. The first collection we did we had a colour that was quite red but actually came back with really good results which actually I was quite surprised by

Becky: Is that the collections the upperlands, sperrin jewel those reds. They're beautiful, but they're not too saturated are they so has that been easier with the printing

Duncan: I think the biggest thing with the jewel print, one of the things I wanted to do when we started the brand, digital print to me has been adopted quite widely in the last 5 years as just the new production method with a lower set of costs, easier to deal with and most of the time its just adopting the old styles into new production method. I don't think we're quite there with digital printing in terms of having, large areas of flat colour on a fairly open linen you're not going to get a nice result. For me its always about trying to, if I look at a design I like to think why should I screen print that or why I should digitally print that so for me its always got to be about digital print should be about really high colour count, lots of movement lots of tone that to me is when digital comes into its own. And when you've got designs that have a huge amount of colour you tend not to run into colour issues in terms of reproducibility, its harder if you don't have large areas of flat colour its harder to pin point a colour that is off.

Becky: One of the things that I've been noticing that more and more brands seem to be doing more patterned fabrics because they're easier to represent online say because the patterns breaks up that flat colour so you're not expecting it to be a particular red. Because, sorry I'm trying to look at my questions at the same time. Do you feel you have an instinctive sense of colour or is that something? I'm trying to sort of identify whether designers sort of I know how I design and how I think about colour, I go ooh yeah that will work with that and I just know that it will work with that. And its difficult for me to explain to somebody else but I do think that perhaps designers have this sort of tacit knowledge but they've learnt it through experience through getting things wrong rather than being magicians, if you see what I mean, what would you say about your colour style do you tend to go back to the same colour palettes or do you like to have a different colour palette depending on what you're inspired by, or who you're working for

Duncan: Definitely I like varied palettes I would say. I think more often than not a palette will originate from a photograph usually one that I've taken myself for me that's probably one of the easiest ways, if you've got an image that draws your attention you know there's a reason why and that's down to 1. The colours that are in it and 2 the balance of the colours how they disseminate across the image. Generally, then I would try to recreate that in the design and separations.

Becky: And is there anybody that you think who is using digital print in a really distinctive and unique way? Other than yourself obviously

[29.05]

Duncan: Let me think. I love the work that Black Pop do

Becky: Yes, and they're such amazing women as well

Duncan: Yeah I love what they do and obviously timorous beasties stuff is great their digital work. It's a bit more difficult in the furnishings market in fact now you've got me thinking. Who else. Not that I like the designs but I appreciate the approach would be the Christian Lacroix for Designers Guild to me the, just the print that they produce needs to be digitally produced because to screen print it would be a ridiculous cost that's where I see digital print working well.

There's also House of Hackney I love what they're doing. Who else. There's one name which is escaping me at the moment I really can't think of. There are a few out there that are doing it well. Especially from my time at [REDACTED DPB Y] we were producing prints for people it was just a lot of people producing their old range of screen designs but digitally and basically it's a crime against the screen prints because it's a shame for the digital because if you've got something that has been beautifully screen printed its just never going to look as nice done digitally its not going to have the quality and the depth so for me people that are using digital well have a high colour count, playing with scale, using big designs, also badgers of bohemia. They are very similar to house of hackney, I'm trying to remember the girls name, I think she did work for house of hackney for a while very similar style. There's one other big brand that will come back to me **Becky:** Do you think that you can spot a digital print to a screen print then going through the, seeing a collection or going round Decorex or something you'd be able to go yup that's digitally printed.

Duncan: I would like to think so. I think if I was close enough to the fabric, if you showed me an image well, but if I was close enough to the fabric then yeah.

Becky: And what do you think, at FESPA one of the things that was distressing me so much was that all the ink and dye stands were all promoting pigment inks because obviously you don't have all these processes but for me the colours were really really flat and dull but it did seem to be very much the way that the print industry wanted to be moving towards

Duncan: Yeah I think so but I mean when I first before I joined William Clark I had been looking at getting a printer myself and I went to see a manufacturer and they were trying to push me down the pigment route so I took a sample way of pigment, an active sample, and I washed them on a regular 40-degree wash and just the fading on the pigment was terrible, hideous. Yeah that's a big thing for me I can't get into the pigment while especially when you're working in interiors you need the penetration of the fibre people will be touching your fabrics, whether it's a cushion or upholstery, they will be rubbing on it and for me the pigment just doesn't cut it. I get it from the not needing all the auxiliary equipment which is usually expensive but to me its just the poor alternative at the moment

[33.00]

Becky: And what do you think of dye sublimation?

Duncan: Its not something I've worked a great deal with

Becky: Its not really good for furnishing fabrics is it

Duncan: I mean dye sublimation has got to be synthetic. This is something that can change quite regularly as well because I think in the last five years they've probably come on leaps and bounds in terms of the synthetic fabrics that are available. At HeimTex there was someone offering polyester plain weave cloth that you'd swear were linen and they didn't have that really nasty feel to the polyester neither I think there's probably a lot of potential in that area and especially when it comes to contracts, contract furnishings and things in commercial places like ships and that kind of thing. But yeah I mean there's just something, I'm not drawn to synthetic fabrics myself really. For me the reactives and the acid dyes that penetrate the fabric are more appealing. I think probably the one thing I'm looking out for you might be able to update me from FESPA was there anything there on VAT dyes for digital printing.

[34.18]

Becky: No not really they were all sublimation inks I mean dyes and pigment inks seemed to be, and everybody was showing off that they had Neons but there wasn't much about VAT dyes it doesn't seem to have yet got to the capabilities

Duncan: Oh right I know there's been a lot of development on that front I know that some of the European companies are working on it and the last thing I heard that there was a couple of

colours they were still struggling on getting the frequency right of going through the head. I don't think it will be that far off to be honest. But saying that as well I think the big advantage the big thing people want from the VAT dyes is the light fastness. At the moment I'm not experiencing huge issues of light fastness I think the worst result I've are colours that were a 5 and that's to be honest pretty good and most of them were a 5 or above. So I think as the dyes progress and people keep, companies keep making tweaks to the components that are needed for the pre-coating there is still scope for that to improve.

Becky: I have to say on all the I make bespoke memory fabrics that are then upholstered onto chairs so its almost like a one off piece of art work but its based around their memories or to do with the furniture that I'm reupholstering and the only problems that I've ever had are with reds fading and lots of these things are now coming up to 10 years old so yeah

Duncan: That's a fairly good lifetime that's not bad. I think that's another thing with the jewel print, while we know that the lightfastness isn't to be honest with you you'll get fading with screen print fabrics too its not unique to digital print but while there's methods you can use in the design process that will make anything like that less noticeable and less likely to cause an issue and I think again that's down to how tone changes through out your design. I think if you are digitally printing flat areas of colour that's going to become very evident very quickly if you've got fading at the edges of your curtains you're going to see a real straight line where as if you've got that tonal movement going through and one of your dyes is fading its going to be a lot gentler issue on the eye

Becky: So do you think as a designer the best you need to be really thinking about how the design works as a digital print and it has to therefore have these tonal gradations which are only possible with digital print to enable it to work as a fabric? And that's how designers can perhaps have a bit more input into this process?

[37.22]

Duncan: It's a tough one I don't think you should necessary the first and foremost thing is you should generate colour and content ideas to create the designs and then from that decide how you are going to produce them. The article needs to be finished first before deciding the production method. The one thing I would always say is don't pick digital because its easy, if you have something that will look beautiful screen printed people will pay for it as well so its all about finding the right production route. But I suppose the one thing I think that probably its important for designers to be aware of that there are variances that occur and if you want to go down the digital print route you need to be aware of if you have large areas of for example printed pale grey and off creams whites and beiges those kind of colours are going to be susceptible to changes in-between different runs of fabric

Becky: So in terms of consistency

Duncan: Yeah in terms of consistency its going to be really difficult to control. Whereas if you have a design that is filled with colour movement its going to be if you want to reproduce that its going to be far easier and I think its especially important if you're a designer starting out and you're doing small runs you don't have you don't have the ability to stock up runs, 100s of metres of one run, the thing is if you understand where digital prints strengths are you can work with them rather than fight against them.

Becky: No that makes sense. And again that reinforces that idea of experience and designers eye being really important in getting the colours right. Do you tend to design in a particular colour space, when your working in Photoshop or AVA are you making sure you're always in RGB or do you use LAB colour?

Duncan: Most of the time I try and work in the right way in AVA so I'm pretty much starting off when I've got my, I've got a couple of profiles that I work with, I've got one that's pretty generic,

and so I'd usually have that on when I'm working. That way the thing I like with starting from scratch in AVA is that you see it the whole way along so you can start to see how your layers interact with each other. You can see how the layers will work with your darkest bit and work from there. It's a whole different kettle of fish when you're in Photoshop I think that's probably and I think you'll probably agree I think that's where most people's frustrations and issues will begin from Photoshop and I just remember a couple of things I have done I would generally tend to work in RGB if I'm working in Photoshop. The biggest thing I've found was an issue even there was a time when I was working with the Polaris we did have AVA we did have an AVA RIP but there was some times colours that it wouldn't hit so we ran an edit rip as well on a PC and we'd use Photoshop files with that and that's probably where I became most aware of the image profiles and the effect that that would have I knew it was because I spent a bit of time talking to AVA there are certain profiles that people use that give them a false impression of what they are going to achieve

Becky: Do you mind me asking you know the profiles you say you tend to work with are they something that AVA have calibrated for your print environment or are they the sort of sRGB or Adobe 1998?

[41.22]

Duncan: No these are ones that have specifically been developed for our cloth. So if we're working on paper we have to get a different profile for the Epson as well. So no from my point of view that's the AVA one is being used you know from the beginning what's achievable on your intended output cloth. There are probably ways around it where I think you could, the designer could ask although they might not, to always ask their printer for their icc profile

Becky: Yeah Its I've that was one of the things I've been asking print bureaus why don't they advise which profile people should be applying to assigning to their designs and it sometimes it seems to be because they don't feel it makes a difference but also but also because they hadn't thought that the designers would even not understand that kind of thing and would need to have a profile

Duncan: Yeah I think I think that pretty common I don't think its something that is massively taught on undergraduate courses as a whole I'm sure there are some situations that are probably doing it. So to me there's probably two reasons why a printer wouldn't be happy to do it 1 you'd see how limited their colour space is which maybe very off putting and 2 say for instance you had requested profiles from three different printers if you got them all into Photoshop and had a look at what was given you to see the most space you're probably going to go with the one that's giving you the most space so I suppose its letting out their limitations if they let people see it. But at the same time it would be more likely to give them a realistic interpretation of what they're likely to get on the cloth.

Becky: I've noticed that some of the print bureaus are now sending out their fabric samples with coloured circles or squares on them and your old employers [REDACTED DPB D]are now doing colour tutorials on their Facebook page and lacuna press who are in Cheltenham they're beginning to sort of do colour tutorials for designers so I think the penny is beginning to drop that there are people out there, I mean there are obviously isn't that cross communication between printing speak and designers speak so perhaps its coming together.

Duncan: Yeah I think that's a problem with this country with education. Since the industry has died away there is very there is less emphasis in the further education colleges on the more scientific side of the colour and to be honest there is a bit of a gulf between production and design and the language is totally different. I find going to things by the SDC mind boggling and I find it very difficult to follow some of the terminology that is used and I've got a fairly good grounding, I've worked with digital print for long enough and worked with software companies

for long enough, so for you know kind of young graduate students it will be a minefield so I think that's probably one of the biggest problems
Becky: Is the education?
[44.47]
Duncan: I think there's, you were saying the colour tutorials, I think that's a great idea and hats off to anyone who is doing that and yes if we could print coloured traffic lights down the side where you've got your colour printing in a separation that's great that's brilliant as long as you have a separated design. If you have a completely digital design that's not separated you can't print those colours down the side, you can but you'd have to get it checked manually put it in. I think to me the biggest, the easiest thing to be if it was easier for the designer at home to have a bigger understanding of what controls they could put in place. Have you looked much at Photoshop image profiles?
Becky: Yes, I've been using my Epson printer here at to sort of print out all the different profiles with the same image to compare the colours and what happens to them all and its been really eye opening actually
Duncan: I wont profess to know very much about the differences. I remember having my conversation with AVA and one that is quite common that crops up is the sRGB profile and do you know anything about this?
Becky: So that's the one we tend to use and if the design is a lot brighter the technician puts it into Adobe 1998 RGB which seems to be more saturated
Duncan: The way it was told to me was that the sRGB has a really when it comes to putting a physical output on paper or cloth the sRGB has a really kind of false value of the depth of black its kind of ludicrously deep and dark so if you're ever doing anything that's got the sRGB profile the changes are you're picking colours that are going to be way in terms of the depth and strength out of possibility for any paper or fabric printer so I always try and avoid that one it might on screen make the design look great but the chances of you hitting those getting the contrast that you're looking at on fabric are really quite slim. Generally, if I am working in Photoshop I tend to use the generic Adobe RGB or 1998 yeah
Becky: That's, cos AVA trained our technician so that's why she puts everything into sRGB how funny. But then we have got the different profiles for the different substrates but she's found it doesn't, they'll always do a new calibration but she always prefers the result of the initial original profiles that they did when they got the machine so
Duncan: Its funny how the profiles work I mean I've had it before where I've got an original profile and I'll go back and make numerous different colour profiles on different batches of cloth and you end up going back to day one and that was the right one. Yeah so it can sometimes it can be over complicated. Yeah so I think there's little things that you can, that designers can do in Photoshop and to be honest that's probably what most people are using probably that or illustrator there are little things that they can do like avoid really deceiving colour profiles I think once you know that and you've got a better idea. And the other one is just calibrating your own monitor which again obviously to do it successfully you need your own kit as well. But yeah to me these are the big things that make a big difference
Becky: Yeah and I think its it can be a big turn off for lots of people because they do just think digital print is sort of magic thing and that's why they get so confused when the results aren't exactly what they want so perhaps they don't complain about it or they don't do anything about it because they don't know where to start. But I mean talking to some of the universities there does seem to be quite a disparity between what students are being taught but there are places like Winchester School of Art who seem to be really thorough and really good about getting students to really sort of repeatedly print out a colour tile that you were saying that you use so

that they could really understand how their red will print or how their orange will print they can just go back and readjust their expectations and their design based on this experience of seeing it actually printed out.
Duncan: I think that's a really useful exercise, I remember working with the students at Belfast art for the college degree show, and saying it's all very well sending me your digital file but I've got no idea of what you're expecting or how it looks on your screen. I always think a great exercise is printing it out on paper. If you print out on paper and it looks totally wrong, then there's a fair chance that whenever you send that to a printer and put it on fabric its not going to look how you want it to look so you need to think first and foremost and try and control it in your own environment. And if you can get the colour reasonably well to how you want it to be on paper then at that point I think you're probably ready to send to the printer but if you're seeing all kinds of weird things coming out your paper printer chances are you getting it on fabric, I mean your paper printer gamuts are generally significantly greater than fabric so if you can't get it on paper you're probably going to struggle on cloth
Becky: And that's even down to your print bureau changing their linen supplier so if the weave is slightly different it changes the whole gamut of the fabric. Its an absolute nightmare. But it sounds like you're achieving good results and I think it has really moved on the technology so much, the technology and the chemistry since I've started out. I'm hopeful for it all
[51.23]
Duncan: Saying that I'm looking at probably my first bigish colour issue since I've been here and its not its pale it's the flax seed design in the stone colour it's the palest thing we do and it's the most problematic because it just always colours that are that delicate they're just so open to swings and what I've found is when you've got a colour that pale you can do a test run but actually when you go into the separates and try and change the colour minute changes have a huge impact on the overall look so any pale colours are just the most difficult you can't trust them. And when it comes to digit lathe brighter the better, the more contrast the better
Becky: Were you taught much about simultaneous contrast and the different contrast effects when you were at university because I know that's something that textile students are often taught about because it has such a great affect on weave and knit and so forth
Duncan: Yeah I think we were pretty lucky I studied I graduated in 2004 we were pretty lucky the first couple of years in textiles and we had we were taught CAD by one of the graduate lecturers and he was really good actually and subsequently I've come across students in more recent times who just don't seem to get a grounding in CAD at all. Not an in depth one. I think there were probably separate things we had really good CAD training just working your way around the software I think sometimes yeah you can be obviously colour balance you really come to yourself as well its just trial and error when I am starting an image or taking an image I have a snap shot of something I've thought that works the proportions of that, they work, colour balance and contrast is something you develop more over time.
[53.55]
Becky: Its often the experimentation that you end up doing with your design in Photoshop anyway tends to be and you start whizzing the tool bars and moving the colour balance up and down and going oh my god that looks awful and subtly moving that back. Do you tend to use a stylus pen like a Wacom and do you find that's helpful in controlling the colour?
Duncan: Hugely I couldn't live without it. Yeah I think I use it for all aspects of working with AVA the design software and tablets are just invaluable. You can make things subtly different than trying to use a mouse and yeah its just easier
Becky: Do you have any particular brushes do you use bespoke brushes or create them, I can't remember in AVA if you can make your own brushes

Duncan: Yeah you can, I do from time to time not always most of the time it involves a drawing or painted line or textures so most of its kind of imported but I have in the past created brushes.
Becky: Are you always printing to linen at William Clark or do you have a range of furnishing fabrics
Duncan: No at the moment we're just doing linen union,
Becky: So that's quite nice to stick to a single substrate
Duncan: Yes, it makes a huge difference. Its very similar to when you're doing it in house the more base cloths you've got the more work you need to do in terms of the chemicals side I mean obviously each cloth has got a different pick up if you're trying to keep it consistent the chemical concentration in the cloth then you need to be tweaking it and adjusting that and measuring it constantly so I think there is a lot that could be done in terms of the fibre working with the cloth give yourself an easier ride you can choose a fibre that's going to create a nicer looking digital product. For me anything that's got viscose in it viscose tends to print beautifully its got that nice sheen to it and there's something about the way that the droplet hits the viscose that kind of gives it a really nice feel so yeah I think the fibre has got a really huge deal when it comes to the quality of the print. But again the quality of the cloth is paramount. As I say its Irish linen we're using. It sounds really clichéd as well but I've worked with linen from Scotland, Belgium, England and Russia, and I have to say that the Irish linen we're using here the quality of the yarn and the weaving is second to none
Becky: yeah with textiles you always want to touch them don't you so it has to be a good quality when you touch it and it doesn't if it has that rubbery feel where its still got a coating on it or synthetic it's a real turn off
Duncan :so at the moment its all linen or variants of linen that we're working with. We have got some cotton and a little bit of silk next door that I keep meaning to do something with but haven't got around to it.
Becky: I'm really conscious that I've taken up an hour of your time Duncan so I really appreciate you being so much of your experience and knowledge. So I hope the information sheet kind of explained what I'll be doing but basically I've made a recording of our conversation because that helps me not to have to take notes so I can concentrate on what you are saying but what I'll do is then transcribe that, it might take me a wee while my transcribing speed isn't high and send you a copy to have a look through and if you're happy that it's an accurate representation and you're happy to consent for me to reference our conversation in my thesis then complete the consent form and return it to me. And I'd be very happy to keep you in the loop about what I'm doing if that's of interest to you and to send you keep in touch really
Duncan: yeah definitely I had one thought just on your when I was reading the notes earlier on. I'm just wondering about the colour palette I see you're looking at the interwar period I'm thinking about the depth and strength of colours that might be in that. I'm presuming I could be totally wrong there's nothing overall-y deep and dark
Becky: Yes, there are so I'm looking at a couple of different designers for that. There's Crysede I don't know if you've heard of them but they were block printers in St Ives in the 20s and 30s and there colours were really bright but they do have some sort of deeper darker colours like a prune all their colour names are amazing they've got tango orange but I'm also looking at the London underground fabrics that Frank Pick had his army of designers he had Paul Nash, Marion Dorn, Enid Nash so they're all kind of sludgy dark colours but as well people like the Omega workshop the Bloomsbury group their colours aren't massively bright and Allan Walton textiles because he got quite a few artists to design for him. So it's a range of colours but I wanted to identify a colour palette so I wasn't getting too overwhelmed by colour

Duncan: Yeah ok I was just wondering, just where you were saying the British home whether you were going to have a spread of colours that were challenging enough but it sounds like you do from what you've said there
Becky: Yeah I hope so I wanted to look at but also personally for me I'm quite drawn to those colours and I feel that often when I sit down to design digitally that goes out the window I can do those if I'm silk screening but if I'm designing digitally my colours can go a bit astray so its kind of a set limitation for me more of a personal thing I think. And then as well the other comparison is that silk screen printing started at that kind of era that change in hand black and copper printing to being able to do brighter bolder colours I thought that that was quite an interesting comparison to a new technology and how it changes peoples design style I suppose
Duncan: Very good sounds very interesting. I hope it goes well and will be interested in seeing how it goes
Becky: Thank you and thank you for your time Duncan I really appreciate it. Thanks for speaking to me. Bye
Duncan: Bye

Design Professional and Consultant

Interviewee: Designer, consultant and artist
Interviewer: Becky Gooby
Date of Interview: 1st March 2017
Method of Interview: Audio Call
Consent given: Yes but requested to have a pseudonym
Transcript approved: Yes
Recording in Designer Consultant.WMA

Duration 1 hour 15 minutes

Summary

Designer Consultant A uses Adobe Photoshop and Adobe Illustrator. She adjusts the colours by eye using the adjustment levels in Adobe Photoshop depending on the type of substrate to be printed upon. She is able to make these adjustments through built up knowledge and experience of digital print. Her approach is intuitive and tacit but based within the knowledge she has of textiles as a textile designer. [2.11] [5.45] She has worked with a range of bureaus and feels that some are better than others. She doesn't use colour management but rather uses colour tools in design software to alter her designs, depending on the intended print surface [9.15] She has worked with X who wrote X – how to guide to DTP - and she has gained knowledge about print from X [13.01] although she and X have never discussed each others working methods. They have an understanding and confidence in each other that the art work they send to print will print as expected. She enjoys seeing how the impact that different substrates will have on colour outcome and her knowledge of textiles and background as a researcher gives her the tools to be confident in making adjustments to her artwork [13.01] She will print a test run first and will ask for a discount from the DPB for this colour sampling [13.39] She has used UK print bureaus only including [Redacted DPB B], Fabpad and [Redacted DPB D] [18.04] [20.17] [21.45] but experienced technical issues with some fabrics running. [24.09] She has experienced issues with particular colours such as greens, oranges, magenta as well as black [26.00] She avoids black and tends to use maroon instead as it looks better against skin tones and prints better. She advises clients that they will encounter problems when printing black [27.16] **Designer Consultant A** often does consultancy work and had a particular client who needed her to match a print on notebooks to tea towels which she did by dulling the colours in the artwork. As a designer she is frequently using her phone to work with, documenting and photographing things with it and then importing them into design software [31.24] She also uses a Wacom tablet and uses calculations to alter data, scale etc [34.14] Sometimes she will use the Pantone libraries in Illustrator or Photoshop or her paper swatches to determine her colour palette [37.36] She feels as a designer that she has an inbuilt sense of colour which for her she calls 'colour magic'. She feels that this colour confidence has been built up from experience and is not something that everybody has initially [45.12]

Designer Consultant A creates her own designs, and offers a consultancy design service for other designers where she translates their design ideas into a useable CAD file format and facilitates the printing process.

Transcript

1st March 2017
18.30
Skype

Prior to recording beginning there was general conversation between Becky and **Designer Consultant A**
Designer Consultant A: I can always send you a copy of my notes
Becky: Yes please
Designer Consultant A And you've got a little baby is that right
Becky: I have, he's 22 months old and upstairs having a bath
Designer Consultant A Ok so That all sounds fascinating and exciting so well done
Becky: Thanks Thanks
Designer Consultant A I know you did send me three questions, just briefly in one of those questions, things to think about, how do you use colour in your work, I'm reading off the screen now, how do you make decisions about colour, what colours are you drawn to, so do you want, I haven't thought about those yet, but I'm going to think about them now
Becky: I wanted to give you an idea of what I was going to ask so you didn't feel that I might be either asking you things that you might not feel were part of your skill set or just to make sure you were happy with those kind of questions really. So don't worry you don't have to answer those immediately. I suppose I wanted to, apart from having been connected with you already…. I just thought that you would be a great person to talk to about digital printing because you're obviously ……in that mix of what this medium is, how it can be used and whether its this, I mean people in industry still think its something you can use for sampling or one offs or to print photographs or photographic imagery and scanned imagery onto fabric so I suppose I wanted to talk to you about your thoughts about digital print as a medium and whether, where you saw it going and why you've tended to use it and all those questions (laughs)
[2.11]
Designer Consultant A That's like mamouth, well first it makes me think, I have got, because obviously I've worked with X on and off for a few years I've got one of her little power points somewhere on my computer that I could send you a copy of it's a sort of introductory power point that she used to give when we'd give a [Research Project] workshop, its just a summary really of the introduction to her first book but that might be nice for you to have a copy of as a document
Becky: Yes please
Designer Consultant A Oh you've gone really quiet
Becky: Oh Sorry
Designer Consultant A Oh that's better, so I'm just going to talk naturally just off the top of my head in that I love digital print, I sort of need it as a designer and an artist, my whole process even if it doesn't always start in the computer, is a computerised process, and I suppose in terms of adjusting colour and those kind of issues I've approached it in different ways its like a blend of the adventure of getting things wrong or being slightly worried or shocked when things come back and its not the right colour to accepting that some bureaus are better than others and some bureaus I wont like their dark colours or the way their black comes back.
Becky: Oh yes black is a difficult one

Designer Consultant A Yeah so it's a combination of that, you'll probably guess that already but that adventure and anticipating this risk area in terms of what comes back getting acquainted through relationships about which bureau I prefer and for which substrate. Then if I'm working professionally for clients and they're not that well versed in different substrates I have to warn them before they get sent their samples, the colours, there's this element of risk with the colours and that can be adjusted to a degree by my services and I'll probably talk to the technical support, I'm thinking right now specifically of a Swedish company who print a paper onto wooden trays, habitat do a lot of those kind of, they've got a nice satin finish often from sustainable wood with a digital print on it, so I'll always make adjustments to my files before I send them in anticipation of what substrate the first sample will be on
[5.45]
Becky: and when you say adjustments are you doing that in the design software or are you embedding a colour profile so that you know that your trying to control the print environment in someway by creating a colour profile or is it just sort of more simplistic?
Designer Consultant A I've actually never done a colour profile, well I probably have done a colour profile in terms of if I've needed to be accurate around Pantone colours but if the work has a kind of artistic element then I'll just know if I'm printing onto paper for example like for the trays which were different because I'm used to doing fabric the way I adjusted the yellow and the contrast I'd sort of do it by eye but I might take screen grabs of the levels, I work a lot with adjustment levels in Photoshop. That's my main areas where I play in anticipation of the substrate. So I might try and make it brighter at the same time not to acidic, I'm thinking of a yellow, but if I was doing the same art work for the same client onto a silk chiffon, because she also wanted scarves to go with the gift ware collection, then I would slightly dull that yellow so it was slightly softer and I'll get to know the different colours that we're working on and what to do with them but I don't really do it, I haven't been systematic about it and done percentages and made it, I might have done that once but generally I don't really do that but I noticed I suppose that I have had a couple of difficult clients over the years I haven't found the whole digital design process easy, usually for contractual problems rather than technical ones but I felt like for one client who was a good client for a long while but then things went quite pear shaped for different reasons that were out of my control I felt like she didn't she had no clue even though she had no clue even though she was winning awards and stuff for being a top print designer she had not clue that, how I was adjusting her art work for the printer, she didn't understand that at all and I could tell that she didn't understand that because when she got other designers to work on her things it came back really dull or bad contrast, bad dynamics so it became apparent to me that was as a designer, a bit of a usp, or I knew that other people she was getting to do similar projects with, they weren't anticipating those digital effects.
[9.15]
So that was interesting as well cos you kind of learn these things you've learnt through trial and error have an impact on client relationships.
Becky: That's really interesting because the people I've spoken to at Leeds university, they were saying similarly, there's a guy called Dr Phil Henry and he developed a colour tool for Photoshop which unfortunately is now a bit defunct, it only worked on cs5 and cs6 and it actually restricted your colour palette so that you couldn't choose a colour that was not printable, he was saying that he felt that actually most textile designers who understand digital print are working in the way that you're describing by using their experience and this tacit knowledge to to control the colour process rather than going down the route of purchasing a particular software or using some of the pantone tools that its really done by experience and learning as you're going along. So that's interesting that you're saying that that is the method that worked for you as well.

Designer Consultant A Yeah I suppose I've never perhaps if I was in a different with a new client where something needed to be more precise I might think about software or intervening processes that could make things more systematic or accurate but, there's been quite a nice intuitive response to experience and applying what I've learnt from that experience. I think also being a textile design graduate its been helpful in terms of the textures of different fabrics and how different linen is to different forms of silk and that I really take pleasure in seeing the colour differences on those fibres and to be honest it wasn't something I felt like I was ever taught or asked about before and even working closely with X all these years I've never told her 'oh before we print that scarf I'm going to adjust the colour slightly for wool, I've never said what I'm going to do, so that's interesting. We haven't agreed it. We've never discussed it, its just like she just trusts that what I send to the printer will be accurate or good for what we're going to do with it. Equally I've never asked her, does she up it, does she adjust it for her prints, so this is the first time I've ever talked to someone about this process. And also I think it comes with research because of course I did a PhD in printed textiles all those years ago and I often feel very much a researcher, its really interesting that the thing that gets you really interested in process and incremental dynamics that makes each person different and slightly secret in their process, its like a researchers mind, so that's interesting that I still everywhere I work I try not to be like a researcher but I've definitely got like a life long researcher in me
[13.01]
Becky: Embedded into you?
Designer Consultant A Yeah it's a sort of pleasure, it's a pleasurable process of enquiry, what happens when you try this.
Becky: Do you do any colour trials? Do you do colour sampling before you do a big print run or are you happy that you've adjusted those levels correctly and its going to be perhaps in the right ball park, maybe not be the exact match, but you're going to be happy with those colours
[13.39]
Designer Consultant A: No It's a bit of both, really the former, so I'll always do a small test run first, its too expensive to get it wrong, I mean there was one time I did that and I knew I was taking a risk and I thought I would do it as almost a fine art piece and the risk was the danger in the piece and that I wanted to embroider it, in fact I've got some samples here (she holds up samples to the screen) they're really like random cos I do a lot of just drawing and painting for my own pleasure and I've only got tiny strips of the selvedge but, so I got like 10 metres of that done without doing a test. It's a drawing that I blew up to 5 metres high but I always planned, although I haven't actually done it yet, if the colour was really bad, even if it wasn't I was then going to experiment with looping embroidery textures over some of the weird colours, so it's the only time I've ever taken that gamble and I did it for like an artistic test but normally I would always have one small area printed to check it first or get the client to check it first.
Becky: and the digital print bureaus you've worked with have been quite happy to do that, have they offered that at a discount or have you found that they've wanted to charge
Designer Consultant A I tend to ask, I actually always tend to ask for a discount and actually generally they say yes so that's been really helpful to be honest I've only, well I've probably used quite a few companies now but you know some companies give me bigger discounts than other companies. I've kind of used, the people's print and I did a big solo show last year I used some of that digital print connection to try and get a reduction and they were really amenable to that so that's always nice to get like 20% off
Becky: Exactly, its just because I've come across, people who are now beginning to look to the continent for printing and looking out of the UK because they've found that the UK companies can be a bit difficult or hesitant to do any discounts for colour trialing whereas in France or Italy

it seems to be the norm to do colour sampling and they'll either be free or a lot lot cheaper. Whereas I was just wondering whether that was something that seemed to be UK wide or whether that was just the experience of the few people I've spoken to so far. Perhaps that's because the continental companies are a bit bigger, larger print runs so they can afford to take that hit

Designer Consultant A Yes I suppose that makes sense because they're big enough companies and more confident and they're more aware that's that's going to be an ongoing requirement especially with high end clients. For fabrics I've just used UK based companies I think so far because I've only been doing sort of small projects. I mean people like, for larger runs I've used people like [Redacted DPB B], and who else, and then, it never actually happened, but doing sampling with ceramics companies and plastic companies in Sweden. For fabircs and silks I haven't gone to Italy and France not yet no.

[18.04]

Becky: Ok, well the people I've been speaking to are [Redacted DPB B] but also the Centre for Advanced Textiles in Glasgow, they seem to be very good with their colour matching and they offer a wide range of fabrics. But Contrado seem to be the ones that a lot of freelance designers are using. They seem to do to about 40 or 50 fabrics including like a wet suit fabric which I think is probably going to be heat sublimation printing. Its amazing the range they do and they also provide a sample pack where there, each fabric is printed with a pattern so you can see the colour differences which is I think something that is a more recent introduction into digital print bureaus because before they've just sort of provide the plain fabrics and now they seem to be trying to help the designers with colour by supplying things like that, or they have colour tutorials on their website showing you how to submit your design and so forth so I feel that the issue is beginning to be acknowledged in the industry which is reassuring rather than feeling like a designer that you're a bit of an idiot and you've got the colours wrong.

Designer Consultant A Yeah I think maybe especially with Contrado because they're quite Joe public face

Becky: They're a bit like Spoonflower I think

Designer Consultant A Aren't they related to Bags of Love

Becky: Yes they are

Designer Consultant A Who've set up the whole user interface for an elderly person to get a photo of their granddaughter on a cushion or whatever so they'll of had to for their own sanity send out samples on request with different, with some of the different fabrics. I used to really like for small, for just samples I really used to like the Fabpad, but I think they've shut that service down now, yeah they don't do it anymore I don't know why I suppose it was too much work and not enough money.

[20.17]

And also [REDACTED DPB D]up at Glasgow they do beautiful stuff on wool for me but sometimes they just don't answer my technical questions. So one scarf I did, ……so I sold a few just to friends or friends of friends. You know they had a baby, one woman's baby was sick, vomited slightly on the scarf and also, and then another woman got caught up in the rain in scarf and the colours just went all over the place and they'd paid quite a lot of money for these scarves. So I wrote to, anyway I wrote to, [Redacted DPB D] but they never replied even though I had quite a good relationship with them so I've kind of stopped using them since then. So I didn't in terms of technical support and how forth coming they are, even though they seemed really nice they didn't reply in fact they didn't reply to a couple of requests and I just thought well I'll leave that and go somewhere else.

Becky: No fair enough I think I would too

[21.45]
Designer Consultant A And that's a really important technical issue about colour running, clients out and about in the street going to work.
Becky: Yes terrible, did it run into her other clothing?
Designer Consultant A No I don't think it did but the background, so there were large areas of colour on a plain background and it, just it dripped, I've got it somewhere if you want me to take a photo of it. It just dripped completely into the cream areas. I was really embarrassed actually
Becky: Yes because its your reputation even though you didn't do the printing. Sounds like they perhaps didn't fulfil the secondary processes very well, because you're meant to steam and wash it to fix those colours. So perhaps that didn't happen. Gosh that's awful.
Designer Consultant A And that was all through, I did that all through the [Research Project] email so it was through that connection, and they were really nice because they gave our clients through our workshops discounts, so there was a good working relationship between the [Research Project] but the colours running was not good. Probably I should be anonymous, you know when you said if you want to be anonymous
Becky: Ok do you want a glamorous pseudonym? No fine what I will do is, I will transcribe the recording anyhow and you'd be very welcome if you had the time and wanted to, to read the thesis, the parts that involved you as well and I'm very happy to anonymise is so you'd have all those options to go 'no don't say that, that's private!'
Designer Consultant A Yes definitely I'm going to do that because otherwise its my name and also the [Research Project] association I mustn't do that its not good. Sorry because I know it can be quite nice to be explicit in specific case studies
[24.09]
Becky: The other option I can do is we can always redact stuff so that its only seen by the examiners and no one else, but we can always, as I say I can show you all the things and we can, that's fine I'm very happy to.
Designer Consultant A Yes please
Becky: Have you had problems with colour consistency, because I've had designers say to me that they've printed, had one batch of designs printed, they've sold out and the retailer has said yes please we'd like some more and they've had it reprinted and the colours are not quite the same and where they've gone back into the shop it no longer matches the particular range the retailer was selling
Designer Consultant A Yeah I can quite imagine that happening because you know stuff that comes back, there are certain colours like greens, I often find, certain colours greens, oranges, magenta often come back slightly different. Thankfully so far I'm not really selling lots of ranges through, repeat orders to the same retailer, I'm not really retail I'm more client based. So consistency I think there probably have been consistency issues but its more to do with relating them to the client saying well you ordered that series of note books to match that series of tea towels and I adjusted the colours accordingly but the notebooks have come out much duller in tone so through different substrates and different printers and different substrates there's been issues with consistency to try and make it all look the same.
[26.00]
Becky: Across the substrates. Would you consciously avoid using greens oranges and magentas in a design you know has got to cross several products?
Designer Consultant A Yes I might be a bit frightened of them I might I don't like to think that I would not use them but I'd be aware of them and aware of certain dark colours yeah. I've actually stopped for my own work I've stopped using black and went for a really deep sort of maroon burgundy shade which is always a bit warmer against the skin for garments. Yeah that

was because I suppose that decision was made because black was looked weird or ran across the edges so that was the one time I thought well I'm avoiding that colour and I haven't, I think I've tried to avoid it since or I've warned a client there's a lot of black in here you need to be aware that that might be problematic.
[27.16]
Becky: When I work with the technician at UWE she often puts black compensation into the design which increase the black and that means some of the lines can sort of almost over run, it gives it that kind of slightly, it loses the sharpness of the design, it sort of changes the pixel layout. I think, that's a technical term. I think that must be pretty standard that black compensation, because its done in the graphics industry in the paper printing and it seems that lots of textile printers are continuing paper practices and I wonder if that doesn't work because a fabric is woven and the ink will be absorbed into the fabric
Designer Consultant A How interesting.
Becky: Because the research I've been reading has said that depending on the weave of the design the colours completely change, so it could be a linen,a chunkier weave and therefore the colours will be completely different. So yeah it's a big battle I think.
[28.33]
And because your design work to me, from what I've seen, you don't tend to use photographic images do you. But perhaps do you use scans of your paintings and scans of your drawings? Or do you use a tablet to draw?
Designer Consultant A It depends on what I'm doing. Ok so just, I mean I'm always sort of shifting around different techniques. And I suppose every year I try out something new, just to keep me interested. Just recently what have I been doing. I've just after years of planning to do this I've just started painting with gouache and often just photographing it on my phone, my phone is how I do a lot of my process. You're nodding like
Becky: Yes this is also part of mine
Designer Consultant A So this is hot off the press. I hadn't done a gouache painting ever, and I thought, because the next project I want to do. I want to get into women's, really commercial high end women's wear. So not knowing anything about gouache I did this painting from some flowers and I thought I'm going to photograph it at this stage (holds image to webcam) so I sort of did it at that stage and then half an hour later after it had dried and I added some more things and make it a bit more detailed and all I've had time to do so far is I've scanned in the latter one yesterday and I just get so much pleasure, I actually have pleasurable sensations taking it into Photoshop, and just going crazy with it.
Becky: So are you scanning the painting or are you going from the photograph you've taken on the phone
Designer Consultant A I'm just going on the photograph I've taken on the phone nearly all the time nowadays because I suppose I work quite a lot in between Illustrator and Photoshop and I quite like the blocky style, stencil like prints so the quality doesn't have to be super duper
[31.24]
Although I wasn't going to do this at all, this style, I've just got carried away and done some filters, (holds image to webcam) that painting, then became that although I only made it that complicated so I could put it on the internet to get some feedback but the actual designs I want to do for a textile agent will be less complex but using the same painting and the same technique. So I can't remember what you asked me, whether I paint or
Becky: I was asking whether you made the paintings, scanned them in or photographed them, or whether you used a Wacom Bamboo tablet to sort of draw or you can get amazing touch screens you can draw with your finger, kind of like David Hockney style.

Designer Consultant A I kind of try all of them, so over the years it just depends on how much time I have. So I wrote this book with a colleague and that's one of my designs on the front (holds up book to webcam)
Becky: Yes I saw those on your website, I love those, and they're animations aren't they?
Designer Consultant A They're animations and they start off, actually in terms of process, this started off as a workshop idea, and then with the [Research Project] I wrote a workshop tutorial about how to use mathematical grids precisely in illustrator so it sort of starts off as a workshop for educational processes, but then I choose my workshop topics, as does X, as an excuse to find out how to do it myself
Becky: Well so you should!
Designer Consultant A So yeah its got double purpose. So I mean nowadays I have to be patient because its like plod plod plod its like doing maths GCSE or something and that's just working with the mouse. But then I've got the biggest Wacom thing you've ever seen I've had it for years. I only just got it out recently to re-use it cos I used it maybe 10 years ago thinking oh I'll do landscapes or drawing.
[34.14]
But actually nowadays my skills are so much better in Illustrator and Photoshop that I want to start using that more.
Becky: I suppose I ask the question because obviously if you're painting and then taking a photograph you've got a colour change there for the digital image that you're then going to import into Photoshop, whereas if you draw just in to Photoshop you haven't. But that's very much how I work so its not a criticism its just more interesting to find out other peoples working processes because I often photograph stuff bring it into Photoshop, draw over them, print things out, print stuff over them and then scan them in, and I never actually considered that that would be adding an extra dimension to my colour. So its nice to know that I'm not the only one doing that and I think its actually quite a common working method for textile designers
Designer Consultant A Quite common? Yeah I'm sure. Let me show you another example. I suppose what I'm saying is basically, in answer to your question, I use a whole variety of different methods. So for that scarf (holds up image to webcam), that wool scarf, that's all done in illustrator, I'm literally picking my colours, for the tutorial we pretended I'd painted it, but actually I did it all in Illustrator, so that's following Pantone colours, certainly any work that I've done similar, being much more precise with my colours.
Becky: Because I'm looking at the Pantone colour range in particular because I think its quite common for designers to use it as a tool, its industry wide, it can be understood outside the textile industry because obviously a lot of graphic designers are into digital textile printing and it surprised me that about a fifth of Pantone colours are not printable anyway, with CMYK inks / dyes, cyan yellow magenta they're not able to make up about 266 pantone colours if you use those standard inks. So even following one of those colour tools doesn't guarantee you that you're going to get that colour. And I had heard that purples, pinks, reds oranges seem to be quite high up in that range of unprintable colours. So its interesting that you had come across similarly. So I'm going to be looking at those Pantone colour sand try and develop a tool or something around that, something that designers can access. Would you think that that would be a good way to go, sorry I'm losing my words. Do you think Pantone is a good colour tool, that that would be something people would find accessible?
[37.36]
Designer Consultant A I think so I mean I always keep my paper, my Pantone paper thingy, where is it? Here it is, I have everything within arms reach. I just bought this really cheaply from some stationers like a million years ago and I'm amazed when I use it, its quite important when I

use it, I'm like ah my Pantone selection and it makes me feel like I'm even if this is a total fantasy, it makes me feel like I'm looking at colours as they should be, rather than in Photoshop, or in Illustrator in one of the colour books. So definitely be interested in like finding out which ones are those 266 colours that I can't use. It will probably be exactly the ones I want to use.
Becky: So looking at them so far they often seem to be the quite saturated ones that look really nice on the screen and when the computer moves them into a printable space they often become a lot greyer and duller so when they're printed they don't have that zing to them. Which I suppose you wouldn't have anyhow if you're looking at a screen you're looking at light and when its printed on cloth its not reflected colour. But yeah it was really interesting to see that those zingy colours were made a lot darker than you were expecting. So I'm trying to produce at the moment a printed book of all the colours. I've printed them out onto different substrates so you can see the differences between the substrates but also what colour it will be mapped to once printed so yeah that's my latest project.
[39.54]
Designer Consultant A Yeah that sounds really good I mean in a way its something a tool kit that you could supply all sorts of print bureaus and maker spaces with, libraries and all those places where actually, most people would actually want to buy on line and have it in their own studio. To access. Yeah that sounds really good because then it makes the process systematic, takes the risk out, especially with dialogue with other people, although in a way I actually do feel that that's my methods which are just totally, I don't know what the word is, my own quirky discovery or what I feel happy with picking the colours I feel like I offer something slightly different from other people and that if I had to share the knowledge, If I had to share it, or it was like open source I would be like shit no I want to use my optical, I might be completely wrong, but part of my self conviction as a designer is that I have a particular colour vision and relationship with colour and luminosity which some people, people nearly always say oh your colours are so bright I do tend to use bright colours which isn't very northern its not very British to use bright colours so that's interesting colour is often the topic that comes up with most people whoever they are who look at my work so yeah its interesting your tool sounds really ideal especially when it comes to consistency and open communication where everyone's on the same level playing field but also I quite like the mystery that the designer has in the clients eyes of being able to decipher a particular luminosity their product.
Becky: To have your own USP, '**Designer Consultant A** Magic Textiles' ☺
Designer Consultant A: Don't burst my bubble
Becky: No, but this is a competitive market there are a lot of people out there as a designer so you do need to have our uniqueness as a designer and to be as your saying, what your saying, coming across as, is that other designers haven't got this knowledge of how to get the colours right, that's fair that you want to retain your knowledge that you've developed from your own experience and skill set. That's part of your uniqueness its important to retain it so that you don't give it away to everybody else
Designer Consultant A Yeah they're interesting questions. And also being a teacher and doing a lot of teaching you appreciate teaching and what teaching has done for me offering me a regular income and all that kind of thing structure and income and a way to help younger students and designers coming up and but I've learnt so much about what experience does. I know that sounds really obvious but there's one girl I've worked with on and off teaching her just a little bit to learn Illustrator and Photoshop and she's so sort of charming and young and enthusiastic and wants to learn that she's been my assistant and she's been an assistant at the [Research Project] workshops, not dealing with the technical side but just with the people side and then she eaves drops and tries to find out what our colour secrets are and even though

she's learning the techniques she can't quite flourish yet as a designer, she can't quite get into the thing and say this is my thing this is what I can do. So its interesting as you mature as a designer all the sort of tacit knowledge it becomes quite valuable and you realise when people are younger it does feel like oh they've got some sort of mysterious thing what is that and colour is definitely and colour and colour interpretation is definitely part of that mystery [45.12]

Becky: and which designers would you say at the moment would you say, who are using digital print, who are using it in an interesting way, who would you say. I mean I've looked at people like Basso and Brooke but who would you say

Designer Consultant A A couple of people spring to mind, I really noticed actually someone had had because I subscribe to textile design jobs listings so if there's Mary Katrenzo is looking for a new head of print I see all those jobs come in my inbox and I think from just looking at the catwalks last week I think Alice Temperley for the first time. Because I knew her at college and I always felt like I loved her style and I love what she does but I felt certainly with digital print up until this collection its been quite tight not that fluid and then I think then I notice one dress she's got this one dress in the entire collection that made me think ah she's got a new head of print I can see it, its something, it just lifts slightly, there's greater skill, its just a symmetrical print on a dress but I thought ah yeah you've got a new design team for digital print so that was nice to see a transition. (http://www.temperleylondon.com/lookbook/Winter-2017---17W) and something I noticed and I'm presuming although I might be wrong that it was digital but something really different that I really liked, it was quite a few seasons back now, Burberry they did fluid floral print inspired by Collier Campbell inspired by Sarah Campbells style, big boisterous strokes and I thought ah that's lovely its like watercolour done by hand but large on chiffon and on translucent fabrics.(http://metro.co.uk/2014/09/15/burberrys-springsummer-2015-insect-themed-show-has-the-fashion-crowd-buzzing-4869655/)

So they're a bit romantic I suppose. I go for romantic. I'm always fascinated by what Katranzou does in every collection I think from the most compelling digital collection she did for me where these interiors well she did two actually, there was the Spring Summer where she did interiors on the forms and a lot of the skirts were like lampshade shaped I thought they were really interesting from a conceptual point of view

Becky: She's had to introduce a lot of embellishment hasn't she to stop people copying her designs is that right?

Designer Consultant A I suppose so

Becky: They've become a lot more complicated her prints I think, because I did see ltos of replicas coming out on the high street after she introduced her first collection

Designer Consultant A Oh yeah for sure, quite horrible ones. But also what she designs is incredibly difficult to wear both from a practical point of view and an aesthetic one but what I love about her designs and no one seems to talk about this fashion is an expression about how your feeling, it might be how you're feeling on your own but it also might be how you're feeling when youre going to be in a particular office and they're all going to see you there so its definitely an impression of your internal state of mind or thinking of that day. And Katranzou is one of the few mainstream international print women's wear who really alludes to I think internal landscapes in her prints, they're really commercial but I think it was a Winter collection where there were just beautiful snow like photographic landscapes and silhouettes of branches against white snow covered hills and things modelled mostly by Asian Chinese Japanese looking models and the photo shoots for those were incredible because of the trompe l'oeil effect. This model wearing this landscape on her. They were just incredible and I thought wow its like an

internal landscape being revealed like a dream you can see her dream. So Katranzou has always fascinated me like that (http://www.marykatrantzou.com/)
[50.44]
So she's presumably very commercially successful even though its quite difficult imagery and clothing. So I suppose I'm sure there are other people. Other people fascinate me but I think, like years ago Peter Pilotto (http://www.peterpilotto.com)he was quite fascinating he was a bit like Katranzou but much better and so symmetrical and that sort of intense collage effect and lots of flowers
Becky: And people use the mirroring effect, I find, with digital, print, because it is interesting to see it on the body, I suppose but its almost a bit of a pastiche these days, the mirror filter. I quite like what Timorous Beasties are doing these days, I think its interesting how they've used almost like graffiti spray brushes that they've put into Photoshop and put onto chairs and things and so forth
Designer Consultant A Are they doing it in Photoshop
Becky: I don't know what sort of software they are using but they must be using some sort of brush tool, I mean Illustrator has some great brushes hasn't it, they're obviously, whether they are, I'd love to imagine them up in Glasgow with a whole lot of spray cans spraying lots of stuff and then importing that in but perhaps it must be a brush tool
Designer Consultant A They're really hands on chaps aren't they. I can imagine, I haven't seen the particular prints that you're talking about but I can imagine they're like, what was the 1950s psychologist called where you had to
Becky: Oh yes where you had to say what you saw in the print and that would tell them a lot about your personality yes I know exactly what you mean
Designer Consultant A Years ago I used to teach children and I used to do that workshop with children (holds up image to webcam)
Becky: oh Wow that's just like timorous beasties
Designer Consultant A these are just from the lesson, the children were only about aged 6.
Becky: they're lovely
Designer Consultant A Aren't they I've kept them on my wall ever since because they're brilliant you can, I wouldn't be surprised if Timorous Beasties had done some of the original images in ink and then scanned them in and maybe applied a filter as well. How interesting, will you contact them?
Becky: I contacted them for my Masters and managed to interview them, to interview Paul I think, so I will try again, I mean they're much much bigger now then they were then. I'm trying to contact a range of people so freelance designers I'm also contacting SMEs like Studio Flock, I'm speaking to Jenny, because obviously they are making the products themselves and they're branching into upholstery and rug design and their designers are new graduates so they've got sort of hand holding people with less experience but they're also having to make the products and go to the retailers so I think they'll be quite an interesting dynamic to speak to
Designer Consultant A Like a new model?
Becky: Yeah and I think from the collection that they've got they're quite contemporary lots of geometric designs but there are lots of quite not singular colours but I suppose there's translucency in some of their designs so you can tell they are digitally printed but there is quite an overlap between silk screen printing with the stuff that they are doing they are quite traditional designs so its why they're digitally printing and not silk screening I suppose but yes I'm also hoping to speak to people like Paul Smith and Ted Baker because they're using digital print but they're a much more commercial brand. Not doing so much art stuff which is kind of where my stuff is, more one offs, at the moment, one offs and arty stuff, so I want to speak to

people who get it right and it has to be right across the whole country and abroad and so forth we'll see who will speak to me, I maybe have a contact at Marks and Spencers who might speak to me as well so that would be good because they're quite well set up with their colour consistency, well I know they are with their traditional stuff so it will be interesting to see, whether they're doing anything particular for digital print. And then speaking to some of the big data companies like Natific who, they map data for dye houses, so they're the ones who can say to you the lab test that comes back is the right spectrophotometer measurement for the original design you said to when you get the garment into the shop, its still the right colour. So I'm trying to speak to a whole range I think

Designer Consultant A That sounds good, its fascinating

Becky Yeah I'm really enjoying it so far, and I'm also hoping to speak to people like Susan Carden up in Glasgow whose been experimenting with her own coatings. So digital fabrics are coated because you can't put a lot of the gubbins that you put in the binders and the things that help with lightfastness and things that help with wash ability is normally in the dye or the ink and you can't put that in the digital textile ink because it clogs up the nozzles so you put it in the coating so the coating you use will really affect the colour and she's been making all these coatings herself and sort of only coating parts of the fabric and coating old lace and printing on that and that all sounds really interesting and quite a niche direction to be going in and so

Designer Consultant A: Whats her name?

Becky: Susan Carden, shes' just written a book on digital textile printing where she compares she says you shouldn't really look at the history of textile printing and then plonk digital textile printing next to it because its not the same process.

[57.29]

She says really you should compare it to cave painting where you'd put the ink into your mouth and spray it over your hand like graffiti because that's what's happening with an ink jet printer and she says where as block printing and screen printing are pushing the ink through that's nothing like it so she's going right back to like really ancient methods of making a mark and comparing it to inkjet printing so she's a really interesting lady

Designer Consultant A: That is really interesting. I hadn't heard of her but X probably has, X will know if there's a new book on digital printing she'll know about that. See what the competition is

Becky: I remember going to Chelsea College of Art and finding it must have been a preproof of her book for students at Chelsea and photocopying the whole thing before her book came out because it had similar tutorials that she must have used as course materials. And then I bought the book as well when it came out so she didn't lose out on the money.

Designer Consultant A I think that's a brilliant book, it was like a game changer that book

Becky: It so was and that time when I was doing my Masters in 2008/9 it seemed like a real turning point for digital print. There were only a couple of digital print bureaus. Now there are loads and all sorts. Oh and someone else I am speaking to are RedBubble who are American and they are similar to bags of love. They have a bank of artists and you chose the artwork that you like and say I like that on my duvet RedBubble please print it and then they send it to you. So you as an artist for free have a portfolio of your designs and you get commission when they're printed but they have such a range of fashion, homeware, ceramics, phone covers so again they've got that issue of the different substrates so how do they get that consistency as well as presenting how they get the colours to look right on the web as well because that's how you'll see your product. So yeah

Designer Consultant A This is fascinating

Becky: When I applied I never thought I'd be looking in all these places but yeah its really good

Designer Consultant A So you'll be an expert you'll know you'll know what everyones doing
Becky: hopefully. Let me just have a look through all my questions check whether there was anything else I was meant to be asking you. Have we run out of time Designer Consultant A, we have haven't we?
Designer Consultant A Give me one last question, two last questions
Becky: Ok Can you tell the difference between a digitally printed design and a more traditionally printed design? Do you think its quite easy to tell the difference
Designer Consultant A I think I can, yeah, although I did have an argument with K Politivitz the former head of textiles at Chelsea we disagreed over whether something was silk screen printed or not but generally I think I can tell straight away
Becky and do you think that's because of the look of it or do you think its because that's got 100 colours in it so therefore you couldn't print it any other way but digitally
Designer Consultant A The kind of fabric, the kind of colours, like if you go to liberty scarf hall that's a really good way of seeing traditional formats in all sorts of traditional fabrics and then you can just almost from far way tell which is screen printed and which is digitally printed. So there's that famous mineral Professor, maybe he's Professor of Architecture but he's got a hobby of taking photographs of minerals but all his scarves they kind of all look lush and of all the scarves you think that's the one I'd kind of like to be looking good in but the actual fabric I wouldn't necessarily feel good in it because it's a satin polyester and its very much on one side of the cloth only so it's a bit disappointing. From far away, if you were going to blog a selfie it would look fab but the actual experience of wearing is not nice so that's bit of an issue. And then I sort of love both though but it depends on what the fabrics are
Becky: And what the purpose of the design is for
Designer Consultant A I mean some of my old scarves I love because they're silk screen printed and the colour is beautiful on both sides and it has the aesthetic of a screen print.
Becky: And you get those fugitive colours where a colour is overlapped over another and created a new colour
Designer Consultant A Yes that kind of thing I'm just looking at old sort of, I'm doing new workshops at the moment and Vera Neumann (https://www.thewomensroomblog.com/2010/04/10/style-icon-vera-neumann/), I don't know if you know her from the 1960s and she has a lovely book X has all her scarves and they were all silk screen printed from her watercolours and collages and they were all silk screen printed but the overlaps of colour are gorgeous. So yeah broadly I suppose I do notice and sometimes its for the better and sometimes its for the worse.
[1.04.15]
Sometimes it will make me me want to buy something and other times I'll feel repelled by the digital print. There's a subtle, sometimes its just horrible, and you know its cheap and its on a cheap polyester and as soon as you wear it you'll start to feel like some sort of robot.
Becky: I know what you mean. Because I'm looking at a lot of the Interwar textiles because I'm trying to limit the colours I'm looking at and because I like that colour palette and looking at some of the original stuff of that I'm like wow that is beautiful
Designer Consultant A: Have you been to see some of that?
Becky Yeah so I've been to in the V&A archives but also to St Ives to look at the Crysede archives, Alec Walker and Tom Heron, Patrick Heron's father and they did all this beautiful block printing in 1920s and 30s, most amazing hot pink and turquoise blue and really great stuff, but also looking at people like Marion Dorn, Enid Marx, Paul Nash and the textiles that they did for London Underground and people like Allan Walton and Edinburgh Weavers and Bloomsbury Group textiles

Designer Consultant A: and just British?
Becky: Yeah mainly British at the moment. I went to see the Josef Frank at the Fashion and Textiles Museum yesterday and it was lovely but I do need to limit and have an end point a beginning and end point because otherwise there are just too many colours to cope with and try and look at those particular colour palettes because you wouldn't necessarily look at them on screen anyway because they are those duller colours that don't look so great on screen but they look nice printed often
Designer Consultant A: So who worked with Tom Heron you mentioned someone called Alec
Becky: Alec Walker so his dad owned a textile mill and he got in with the whole St Ives Jazz set in the 20s and 30s and he was a painter and he was trying to be like a Fauvist and his paintings typically he met and married this woman and she basically did all the donkey work and she was the designer who designed all the clothes and I think she probably turned his paintings into the repeat and the textile designs they became and they were all printed by hand in St Ives and they were sold in New York Paris as really high end gowns and the PenLee Museum in Penzance have got this wonderful archive of all the swatch books and dresses but they've also got things like tea cosies where the women who printed the fabric would nick a bit and obviously go home and run up a tea cosy or a tie or set of curtains in these wonderful very garish 1920s jazz textiles so looking at different colours
Designer Consultant A Becky that sounds so nice
Becky: Yeah I'm having the best time
Designer Consultant A Its so nice to talk to someone who is so into textiles
Becky I could at the moment bore anyone to death with what I'm doing
Designer Consultant A you know there are not enough of us
Becky No there aren't and I think some people have been hesitant to talk to me because I don't think textile researchers are common enough, its just not done. Especially the academics here at UWE who just don't they seem to shy away from research. But I've got supervisors down at Falmouth as well as part of the doctoral training centre I'm in, its Falmouth Plymouth and UWE so I've got the textiles team at Falmouth as well they're really good
Designer Consultant A Yes they must be a bit more up on it than what you're getting at Bristol I went to college with Hannah Morgan she's one of the researchers at Falmouth, Hannah Morgan or Maughn I don't know how you pronounce it
Becky: I'll look her up. I'm working with Simon Clarke Head of Printed Textiles there, he's written a few printed textiles books they're more kind of teaching books but he's been really helpful
Designer Consultant A Well if you want, or if you think of anyone you want to meet. In my Slow Textiles group its really nice because lots of people who are practicing in all sorts of different ways they come to events and that's really nice because I think a lot of the MA courses like at the Royal Collage there are so many overseas students who often don't really speak that good English and they're a bit shy and then they graduate and go back to their country of origin I've really noticed that because ive been teaching since 93 or 94 there used to be loads of British graduates around and you'd keep seeing them for 20 years and there's now only a handful because they return overseas because they're the one filling up the courses
Becky: Yeah it was like that at when I was at Chelsea but only for my foundation and then I got onto the course to do the BA but I was one of a handful of British students, it was mainly Chinese, at Chelsea BA, so I left London and went to Bath Spa and then came back to London
Designer Consultant A I met you at London Met didn't I, where are you from originally?
Becky: London, I'm from West Norwood

Designer Consultant A I'm from Camden Town, Bristol is nice isn't it, I've never spent time there but it seems like there's lots happening and textiles stuff happening
Becky: Yes there is and there's the Bristol Textiles Quarter, its more knit and weave I think at the moment. Its improving and improving all the time because everyone is moving out of London because they can't afford to do what they want to do so that's working to my advantage [1.11.27]
Designer Consultant A Babs Behan? She runs Botanical Inks, she helped and is part of the Bristol Textile Quarter, because I run the studio now in West Hampstead. This really old studio in West Hampstead, its really run down, there are about 50 artist's studios. And I decided to share the rent, to sublet, but I would only sublet to textile graduates and that's' quite unusual so on average there are about 9 of us, there are two floors in my studio and we're all just textile people so that's really nice and Babs is going to join us from May for a few months to run workshops from that studio so I'm trying to create a research lab but a continuation of being at college but outside of college because after doing a PhD its quite hard to keep the research conversation going. You can in academia but it gets a bit boring I think but its quite hard to do outside so that's what I've been trying to do really. That's why I've called it the Textile Hub London
Becky: And I think in academia you're pulled in all sorts of ways and have to bring in funding so its nice not to have that pressure
Designer Consultant A which can curb natural progression. Creativity. Its very important to keep in mind
Becky: Thank you so much for your time its been really good to speak with you and I've got lots of information from you so thank you. I'll transcribe the notes and send them to you and would be very pleased to receive yours if you're happy to send them to me and X's PowerPoint. And when I start writing I can let you see stuff and shall I just anonymise it for now and then you don't have to worry about saying about running scarves
Designer Consultant A that sounds great
Becky: because I really need to evidence that other people have this issue and to evidence how people are working with it and anonymous evidence is fine
Designer Consultant A: Very nice to see you and to talk to you and it will take me a couple of days to find the power point and write up the notes
Becky: Oh yes it will take me at least a week or so to transcribe the notes as well, no sense of urgency
Designer Consultant A And if you've got any outstanding questions or just drop me a mail
Becky: I'll keep in touch anyway
Designer Consultant A Yes please
Becky: Have a nice evening and thank you, bye
Designer Consultant A bye, bye.

Emma Kendall- Textile Design Graduate

Interviewee: Emma Kendall, Textile Graduate at TexPrint
Interviewer: Becky Gooby
Date of Interview: 2nd March 2017
Method of Interview: Audio Call
Consent given: Yes
Transcript approved: Yes
Recording in emma kendall.WMA

Summary

During her internship in Italy, she gained industry experience of colour management, where a light box was used to compare printed colour samples to ensure that the print colour was as required. Colour measurement was carried out using a hand held spectrophotometer. This visual colour check was carried out for traditional roller prints. Designs intended for digital print had less colour guidance and controls that she'd expected, for example checking that colours were in gamut or applying colour restrictions in the design software, were not in place. [7.54]

Whilst working in Italy, she was invited, with other TexPrint students, to visit For.tex. For.tex provide dyes and thickener treatments, as well as offering a printing service. [7.54] They are part of the Monna Lisa project which developed a range of digital textile printers through a company called Robustelli. For.tex and Robustelli have both been recently acquired by the Seiko Epson Corporation (For.tex in 2015 and Robustelli in 2016). For.tex printed a sample for each of the TexPrint students on 100% silk of their own designs to demonstrate the print quality and Kendall was really surprised by how well the colours matched her original designs. For.tex have developed their own pre-treatments and post treatments, which coupled with their existing textile chemistry knowledge and high end printers, ensures that they are able to control many of the variables that affect colour in the digital print process. The Monna Lisa range has its own bespoke software and RIP called Leonardo developed to work specifically with the printer inks, Genesta, created for the project.

At University Kendall was not taught to use a particular colour system, such as Pantone, or a method of achieving colour matching in digital print, and so she used designer's eye to guide her colour use in her design work. [13.42] She frequently encountered issues for example teal blues printed much darker, more navy, and many of the photographic images she'd used appeared purple which she found disappointing and frustrating. Kendall would embrace these colour mistakes, printing back over them with fluorescents as she was not sure how to fix them. [16.01] [22.48] Since graduating and undertaking AVA CAD CAM training and internships in industry, [4.32] Kendall has learnt more about screen to print colour differences and now has a better understanding about why the colours may not print as expected. She now uses Pantone references and corresponding RGB values to select colours as well as software restrictions (for example in AVA you can restrict your colour palette to the printer gamut) alongside her own designer's intuition built up through experience.

She has used Digital Print Bureaus and had an unsatisfying experience where unhappy with a print she returned it because the feel of the fabric and colours were not as she expected. The bureau however, disagreed and returned the fabric saying there was no issue but with very little

information to why. This made Kendall feel discouraged and incompetent because she was unhappy with the print but the bureau implied that she should accept the print results.

During our conversation Kendall voiced her frustrations with digital colour saying 'if every colour (seen on screen) has a RGB value and it is made up by a mathematical formula (algorithm) then that is the colour, that is the colour it should be' and 'your monitor should not lie to you'. She expressed a desire for better education on digital colour in design courses which should include practical skills such how to calibrate your monitor and understand the digital print environment, as well as teaching colour communication methods so that designers can understand printer's vocabulary. [41.29]

About
Emma Kendall
New Textile Design Graduate
Selected for TexPrint 2016 - http://www.texprint.org.uk/index.php/year/2016
Awarded internship at textile printers in Lake Como, Italy and AVA CAD CAM Training
https://www.emmakendalldesign.com/
https://www.instagram.com/emmakendall_lifestyle/
Emma Kendall is a freelance textile designer and illustrator. She uses a bright colour palette, frequently including fluorescents. Her style features contemporary florals and expressive mark making. She uses scanned imagery, incorporating photographs, glitter and reflective materials into her work. Her illustrations combine collage and drawings and she has undertaken several mural commissions. Her layering technique features across her work and can be seen in her digital prints. To achieve many of the fluorescent colours and special effects (glow in the dark, flocking and foiling), Kendall hand printed over digitally printed fabrics. She uses a tablet to design with as well as incorporating hand drawn elements, designing primarily in Adobe Photoshop. She uses photography to inspire her design compositions and imagery and translates theses starting points into her 'own handwriting', using paints and ink. These hand rendered elements will then be scanned and manipulated digitally and may incorporate photographic and other scanned imagery.

Transcription of interview with Emma Kendall
Thursday 2nd March 2017

General conversation between Becky and Emma prior to the recording starting

Becky: So how is the mural going
Emma: I'm working on it at the moment, I'll see if I can show you
Becky: Oh wow
Emma: Yeah its really fun, I'm working on the detail but I want to finish it today because I just found a mural job in Shoreditch. And they were like we've got 8 boards and you've got a week to do it, this one wall has taken me a month so I was like I could do it but I'd need to change my technique a bit
Becky: Yeah you'd have to do more of a block style so you could do big areas of colour
Emma: Lots of spray painted stencils I think
Becky: So you've been really busy since TexPrint haven't you, its just been like a whirl wind I suppose

Emma: It was really fun with Paris and London and then Italy and then I came back and got Vivienne Westwood but it wasn't textiles and then in terms of you know someone being like 'oh I really like your print work' it hasn't been as good as you'd hope I think because even though you have to work hard and you have to like want the position you're getting it's a bit of a shame when no ones like oh you're perfect because you've got so much exposure but no ones been like oh yeah we want you to be our print designer so its been like, you do wonder
Becky: I suppose you're at the bottom of the pile at the moment aren't you so everyone is
Emma: Literally that's when you realise how big the pile is
Becky: Yeah
Emma: It's a scary thing, I didn't realise. You're at the bottom of big school. But its good I'm busy so that's all that matters really
Becky: So are you getting to make any work for yourself at the moment to keep up your own practice or are you just doing everything for other people
Emma: No I got a Wacom tablet for Christmas but I've hardly used it. I would if I was designing but I'm not designing so I've done nothing. But I think when I've done this I will do all that stuff. So I wanted to finish this today and then I had the internship and then this and then I want to get back onto Photoshop and act as a designer and I can always be doing it even if its not for money and then hopefully I'll start progressing
Becky: So did you get signed up by any agencies when you were at Premiere vision
Emma: No nothing. So nothing like that but I've had good stuff its all reassuring
Becky: And how was Premiere Vision, so you took your design work to Premiere Vision and you had a good response as in people were interested? Or because I've done those trade shows and things before and its kind of felt like this endless parade of people walking past and people looking at your stuff and you're like do you like this I can't gage what you're thinking. Its quite terrifying
Emma: Yeah it didn't feel like emotionally disappointed, I didn't do very well but I didn't really care like it didn't seem important because its obviously about trends and what people are looking for and other people didn't do that well either so it wasn't like it didn't reflect well on me I wasn't like the worst and we were in a corner because they've changed the layout so the foot traffic wasn't going past that area, there was a really good print designer, international print designer next to me and he was like this is the worst year I'm having such a bad time. I didn't feel bad about it but it wasn't a good trade show.
Becky: The agency that I've been speaking to who are called Made in Brighton but they're based in Bristol they've stopped doing Premiere Vision because they feel that the layout and it just doesn't work any longer for textiles they've stopped doing it. They're doing New York but they're avoiding Paris because they said they've just had such bad experiences where they've either been put in a corner or people have not really, people just seem to be there almost just as an exhibition rather than to do business. So after Premiere Vision you went to, so you did AVA and then Premiere Vision
Emma: Yeah AVA and then Premiere Vision and then Italy
[4.32]
Becky: And you said you were slightly horrified by the colour management practices in Italy
Emma: Yeah I was I was actually really shocked, To be fair in retrospect looking back they did actually have all of the fabrics printed out with all of the colour palettes on so when they were breaking down the colours into high contrasting colours, bright reds, white black and then apply the colours onto layers and they'd go to the light box to make sure they matched the fabric so the fabric they're printing on they'd get the exact colour they want and they would do but I was doing digital, but not rollers and this was for roller printing. But then the digital I was just going

for it and then they wanted me to do something for the collection and then it would come out and it would be completely wrong but there was no pre thought it was really vague and no one seemed to care and definitely from my third year we didn't really get the 'oh you should use pantone for your colour palette' I didn't actually know what pantone was a year ago I didn't know because of the educators so I was like oh well I don't know what pantone is so having never really paid attention to colours before then to go to Italy I was working like I've always worked but after meeting you and what I've learnt I was just so shocked that it wasn't a step ahead and they weren't doing the gamut check box in AVA.
Becky: Because in AVA there's all those different versions of the colour gamut that you can work with so you can see its. I think we did it as a pixel version and then that weird triangle colour space and you can move your colours and make sure that they are in the right space and you can almost do a lot of preplanning don't you in your design you can't just go ooh I like that colour and put it in there
Emma: Oh god no, yeah and they had a spectrophotometer
Becky: Did you get to use it
Emma: Yeah a little bit my AVA has run out now because it finished in January. It was 6 months which is huge but I jus didn't get to use it but I got to use it in Italy which was really good so I did get more confident with it which was good but I didn't get to where I'd like to be but yeah I made this colour palette for AVA but I didn't get to use it
Becky: That's a shame, and then so how long were you in Italy, that was quite a while wasn't it a good month?
Emma: Yeah and we did a week which was common activities week and we went to Fortex have you heard of Fortex
Becky: no
Emma: So Fortex is like the leader in digital print, not a factory it was like a big commercial, they'd have all the printers in there and people would pay them to produce their digital prints.
Becky: So like a really big digital print bureau
Emma: Yeah and they did the highest quality digital print in Europe or the world maybe
Becky: Wow
[7.54]
Emma: So maybe that's worth
Becky: How do you spell it?
Emma: F o r t e x
They educated us on how digital print worked which I didn't know which I found really interesting. All the Kelvin stuff, all that, and how it goes in different directions so you have to change where the ink hits the fabric and they have all the different inks and then they printed off for us one of our designs on the highest quality digital printer on 100% silk and it was actually amazing to see all the colours come out. That was fab
Becky: Did you get to keep that?
Emma: Yeah I've got it I haven't got it here but I've got it at home. If you're in London again I could show you if you're interested.
Becky: I come up to London quite a bit as that's where I'm from so I've got family I can stay with so I'll let you know cos we just came up to see the Josef Frank exhibition and the Vanessa Bell
Emma: Yeah were they good?
Becky: Yeah really good. The Josef Frank exhibition was really nice and I think that they had curated it really well. I've seen stuff at the Fashion and Textiles Museum before that has been a bit like walking round a branch of Marks and Spencers, all these mannequins in really stiff poses wearing a nice frock and you're a bit like ok. But with this they'd printed huge great big I

suppose 3 or 4 metre draped lengths and they'd hung them and then they'd upholstered a whole lot of stuff and then so you could sit on one of the chairs with his prints on them but then they'd also got the original design work which he'd painted I think framed next to the fabric so that was really nice to see and then he'd done coloured squares of what the different colours in the design were right next to his design so that was really nice to get that insight into the working process before computers that was, yeah because you can't imagine how separating colour ways and stuff without a computer these days I suppose
Emma: Yeah possibly. It was actually really interesting, I don't know if I said this before I can't remember why is it that the pre-interwar period?
Becky: So for me I really like those colours and when I've designed using that kind of colour palette those kind of softer muted duller colours they've sold really well, people have been really interested in them. And then they've always always tended to be textiles that people are drawn to some of the textiles from that era like the Bloomsbury group and then Allan Walton and the Edinburgh Weavers they did a lot of work and I think a lot of digital print is being used to recreate a lot of those classic textiles so there's that kind of personal aesthetic that I like about it but also there the colours that you don't tend to choose on the screen because they're not very saturated they've not very bright so you don't tend to design with them so I was thinking that if I did designs with that then that would limit the colours that I had to try and work with and try and get correct so
Emma: so make a refined colour palette, you can't do like the whole, pantone colour ever
Becky: But I have just done every single Pantone colour and created a book of all the pantone colours and worked out which ones are unprintable on a digital printer so I'm sort of doing
Emma: You said a fifth yeah
Becky: Yeah two angles at the moment
Emma: That's not bad though that's ok. To have four fifths printable that's more than I thought it would be. I thought it would be half, when you think about the gamut graph I think four fifths is pretty good
Becky: Yes and its as you say from what a lot of what you're saying the education is lacking in the undergraduate degrees about digital colour and digital printing and so if we got more information whilst we were studying then that would give you more things to be armed with when you went out into the world as a freelancer or doing small jobs you'd be able to say I'm not going to use those colours because they're not printable or I can do these adjustments because that will make it print better on linen
Emma: Yeah they didn't mention it so I wasn't aware that it was an issue to get screen colour to fabric but it never got explained but that could have been my university because I know Meg went to Loughborough and she seemed a lot more clued up about everything in the industry then I was but definitely for Bucks no we didn't do anything.
Becky: I went to Bath Spa and they didn't talk about that either
Emma: Really that's mental. Also in Italy I found out that digital print is just 5%
Becky: Yeah its really small
Emma: I didn't' know I thought it was like 80%
Becky: No its really expensive still
Emma: I couldn't believe it, and I didn't know what roller printing was. Mortifying, so embarrassing
Becky: So you wouldn't do roller printing on an undergraduate course so why would you know about it
Emma: Because you're being educated into the textile industry so you can get a job in it so they should tell you everything

Becky: But you wouldn't have got to work with that process I suppose
Emma It should be in a lecture or a learning module where you have information communicated to you
[13.42]
Becky: Yeah talk about the history of textiles and things yeah I agree
And what were you doing at Vivienne Westwood were you making designs for a particular collection or were you just sort of
Emma: Jewellery development. Yup, so I've always wanted a luxury brand internship and they didn't advertise it as jewellery design so when I applied for it, when I went for interview it was one of my favourite brands and I was like I'm actually into accessories its perfect timing and it all came together really well and then in reality it was just jewellery development and it was awful I did have some standards sorry if I keep talking across you I can't hear can you hear me clearly
Becky Yes I can
Emma: So it was good it was just a month so now I can go back to my own stuff
Becky: did you make any good contacts through it or did you feel a bit like you were treated as a dog's body
Emma: Yeah walking round people were really friendly but the jewellery team were really nasty so I did manage to speak to other people who were nice but the people in the team were just they were a bit they would give me bad information or bad instructions I'd do a task wrong and then they'd have a go at me and they'd have a go at me. It was fun at first I thought it was quite funny but then eventually it got boring but that's over so
Becky: Its on your CV now
Emma: Exactly and it was on my bucket list I was so happy I know it sounds stupid but I always wanted to work there so
Becky: So talking about your own practice because your designs are really bright and you use lots of neons and things in them so do you do you put a lot of planning into that do you set out your colour palette to start off with or do you just work and go oh I like that colour lets see what it looks like and put it on there or do you think about how its going to be printed.? How do you work?
[16.01]
Emma: So definitely in terms of thinking about colour in the third year I wasn't aware I literally did designs work on the photography images had all my prints come through and I'd be so disappointed with a lot of purple all the purple that came through I wasn't aware of all the teals turned navy blue so that was horrible and I just had to deal with it. And obviously I'd print the UVs screen print them over the top so it was quite cool what you were saying earlier about doing the screen print through the digital one at a time that was quite like a cool less messy idea get the inks into the printer that feeds that's really cool. And then I've been to AVA and Italy and spoken to you and I'm more aware of it and now I would look at the Pantone, type in the figures, look at the screen compare it to what I'm looking at in real life try it and I'd do all that kind of stuff but I didn't do that before
Becky: and do you, do you do any hand drawing and scan it in and use photographs and stuff or is it everything done digitally from start to finish
Emma: I'll use photography to find angles compositions and to find imagery from real life but I'll usually always translate that into my own handwriting, the photography to do the composition and then it comes back to painting or ink and then I'll go back on the computer and then maybe combine photos with painted imagery or just use the hand rendered stuff
Becky: and did you find if you printed photographs digitally that they would come out as you expected

Emma No
Becky what kind of issues did you have
Emma: Well it would look amazing on screen and then obviously the purple and navy blue, well it was mainly purple with these photos the maps that was really bad what else I can just see a load of purple
Becky: Well of those Pantone colours I was really shocked to find of the fifth that didn't print the majority were purple and orange and blues and greens. They seemed to be the colours that were the most unprintable so that's interesting that you were saying that that's what you were finding as well
Emma: Yeah with the purple it all turned purple I actually had a lot of things that turned purple I wasn't intending it to be purple It all appeared as imagery which was weird
Becky: And do you know what printer you had at Buckingham, was it a Mimaki
Emma: This was the [Redacted DPB A]
Becky: Did they come back to you and say, did they just provide you with the fabrics and say here you go or did they say ooh the colours are not quite as what your design looked like or
Emma: No they just printed them and said here you go. And I also had a bad experience with them because I received fabric washed habotai, a bit suedey, but it came through crinkly and really crisp, and I thought that's the wrong fabric and I went round to everyone else and said that's not the same fabric as that and everyone agreed with me so they were like oh you can send it back so I sent it back and we've been round the office and we've all agreed it is this habotai so we're sending it back to you. It was really weird and very rude. It puts me off using them definitely. So the colour was wrong and the fabrics were wrong but
Becky: I've had very similar experiences to that so I think that's fairly common I am beginning to find that some of the print bureaus are giving information on how to get the colours right on their website talking about embedding colour profiles into your design so that you can have a bit more of an idea of how the colour is going to come out but for most for how I work I would never have known about that and from speaking to most textile designers most textile designers don't know about that
Emma: Yeah I found out about print proof towards the end so like that's as far as I got was using that but I never really understood it, it really confused me
Becky: No I think, same here I think that's fairly standard I think that's fairly standard I think that's a general way that most textile designers work they either adjust it themselves or they just go oh I don't its confusing its technical and I don't get it so you shy away from it
Emma: And also when you use print proof if you go into a colour palette to pick a colour you still have all the colours so you don't really know when you pick it what's going to happen you know you couldn't see where to click to get close to the colour that you wanted to see if that makes sense you just got what you wanted and it turns out the way its going to be but you couldn't be like oh its going to be like that so I'll do this, there's no solution provided just oh this is what you're going to get.
Becky: So the people I've been speaking to who use digital print bureaus on the continent apparently in France and Italy its much more standard to do colour sampling and colour proofing of your designs for free before you get sent the final design which I found really amazing but also slightly scary that UK digital print bureaus don't do that. So it might just be a UK issue and that our digital print bureaus don't do that as standard so that's slightly worrying
Emma: Interesting as well, so why? Because we're meant to be one of the leading countries as well.
Becky: I think it must come down to cost really but yeah

Emma: Its just funny if they're meant to be that good like they all should have their standards. Because in Italy they were all saying London the UK is the best. Interesting
Becky: So when you get a chance to get back to doing your work do you think you'll continue to do digital printing or because obviously you wont necessarily have access to screen studio to print the neon colours over it or will you? Have you found facilities in London that you can use?
[22.48]
Emma: No I wont screen print I didn't even like it all my nails fell off, I hated all the chemicals, its messy impractical and just big and so much to organise and there's not really a market for it. When I was at uni the screen print samples came in and I always thought like why because they'll only want the digital files and now I've got to make my own money from my designs I want to do more get that illustrated look into my designs using digital and screen prints are quite limited. In terms of fabric, also I do like screen printed leather
Becky: Yeah I don't know of anywhere that does digital printing onto leather yet
Emma: Oh but they do do it I found out. I learnt, where did I learn that, I learnt that Rati do you know Rati its one of the leading mills from 1949 they built this empire, he's got all the archives, all the technical fabric production for interiors and they have luxury fabrics where they do all the hand painting and I found out there that they do digital print onto leather.
Becky: Yeah because my next lot of experiments is to make my own coatings so I can print onto every fabric ever so
Emma: Oh yeah the cows wee, where has that come from
Becky: So I found a couple of recipes in some books that I was reading. Do you know Melanie Bowles and Ceri Isaacs book about digital printing?
[25.06]
Emma: It sounds interesting
Becky: I'll send you the link, it's a really good digital design book for textiles it gives you lots of different tutorials about how to do certain skills. But in the back they talk about research that's gone on and they talked about two academics who are at the London College of Fashion who were coating Victorian lace and then printing on it so that they could upcycle stuff and they put the recipe in there. But there is also a lady up in Glasgow called Susan Carden and she's just written a book about digital textile printing which is actually I wouldn't recommend reading it, its just a bit heavy and laboured but she's done loads of experiments where she's only coated part of the fabric and then put it through so that you get all these patterns where the colours change because some bits are coated and some bits aren't so, and she put her recipe in there as well so yes that's where I've got the chemicals from. I don't know the proportions yet soon. I'm going to experiment and see what happens.
Emma: So is that purely because it's the best or is it from an eco point of view?
Becky: Its purely, I want to be able to print on coloured fabrics and I can't find anywhere that does digital coloured fabrics but also I just want to see what happens because the chemistry researchers say that there isn't an issue in colour in digital textile printing because the coatings should solve it so I thought if I experiment with the coatings myself I could get a sense of why they say there isn't an issue
Emma: That's interesting so they say that the printer isn't the issue its that's it's the way its applied that it's the issue
Becky: They've suggested that its people using the machines incorrectly and also doing, because once you've printed the fabric you have to steam and then wash it to fix the colours so they're saying its those secondary processes of steaming and washing that people are doing incorrectly or that people are not buying the best coated fabric and that's why you're not getting colour matches.

Emma: Who is saying this? The people who produce the fabrics?
Becky: This is the guy, the editor of digital textile printing magazine and he's a chemist, so a colleague here contacted him on my behalf and he said there is not problem its people getting it wrong, working with it wrongly. So yeah I thought I'd try it out
Emma: It is true, but if they had the printers and they're not producing the results and they're not working with them properly then they're not communicating properly on how to use them.
Becky: Yeah I agree. And I also spoke to a company called RedBubble who you should look into actually. They have a bank of artists so you create your own profile and then you upload your artwork and then people can choose your artwork and they can say I'd like your design on a duvet or leggings or a cup and then RedBubble will get it printed and send it out to then you get paid commission. For your design being used so it doesn't cost you anything to create a profile and you can just use designs that you're not massively, you like but they're not the best and then people can use your designs so you might wander down the street and someone might be wearing Emma Kendall leggings. But they were saying when I spoke to the quality control manager there she said bullshit colour is a huge issue and this chemist is an idiot
Emma: Yeah interesting. That's so funny.
Becky: Do you mainly design in Photoshop or do you use Illustrator as well
Emma: So I use mostly Photoshop because that's what I've learnt but I definitely want to push Illustrator because its vector graphics and not pixels
Becky: I've not really learnt Illustrator so I'm trying to teach myself that as well
Emma: I've been learning it over a month but its so hard because teaching yourself is so boring
Becky: Yeah.
Emma: The tutorials show you and it can be too fast. Using google
Becky: I joined up to the make it in design workshops and somebody sent me a website for those of tutorials for Illustrator
Emma: Yeah but you have to sit through them
Becky: Do you think that if you had the option of having AVA, you could actually afford to have it that AVA would be a better program to have than Photoshop?
[31.03]
Emma: I really enjoyed using it, at the moment it's a great working it alongside Photoshop so that you can do your work in Photoshop and import it into AVA then the colour separation is done, repeats and its magical.
Becky: I think that's their USP its why they're so expensive I really like the mock ups I thought they were quite good
Emma: The people there were really nice I wouldn't mind getting AVA or working for someone uses it
Becky: I think Liberty, Mulberry and Burberry all use them so I think they're a good company its just I don't know how I'd be able to afford it as a freelancer sadly
I'm trying to look at my list of questions to see if I'm covering everything
But just jump in and talk if you'd rather
So one of the things I've been asking people is whether you as a designer can tell the difference between a digital print and more traditionally printed whether you're looking a t a design on the catwalk say would you know how it was printed would you be able to tell the difference?
Emma: So judging by the fact that I thought digital was 80% and its actually 5% I would say no. When you live with the fabric you can see that its not I think its important for quality but for fast fashion. But then digital is a surface so its not as good especially when stretch fabrics are so popular
Becky: Yeah because you can see the whiteness of the fabrics when it stretches.

Emma: Yeah so that's interesting
Becky: I suppose on the other hand like as you say access to silk screen facilities if you wanted to set up your own design house its easier to do that than to do small digital print runs
Emma: Ok, I haven't got to manufacturing yet.
Becky: For me it feels more accessible because I can send off the file and get the fabrics back whereas I would find it quite intimidating. Yeah ok I think I've gone through all my questions was there anything you wanted to ask me or was there anything you wanted to cover
Emma: No I think I've asked you everything I wanted to ask, obviously there was the Interwar stuff so that's really interesting.
Becky: I'll send you the links to the book I was talking about and the link to redbubble and anything else but yeah I'll keep in touch let you know anything else I find out because I could always do with guinea pigs people testing things out for me as well
Emma: Yeah definitely I think I'll be doing more print after this and working with the colours so it would be a good time to start incorporating but also I wanted to ask you about calibration. What's the deal with that if the printer is saying its not printable, but can you calibrate your screen so you can see what is possible?
Becky: That's what I want to do is I want to send out some questionnaires to the digital print bureaus and find out just the UK ones for now and find out the type of printers and types of inks and dyes that they're using and get an idea of what's out there what people are working with and then to find out who is providing information to their customers about colour and whether they're, so I don't know whether they'll respond at the moment it might be that its commercially sensitive and I definitely want to highlight to them that there is this issue that people are finding and perhaps they're aware of it but are ignoring it or they don't think its their problem
Emma: And for example are Mac calibrating their monitors for digital print
Becky: So Apple have come up with their own colour space called Apple RGB and there is the international colour, they're called the ICC and they are the people, they're made up of Kodak, Apple, Microsoft and some other companies and they've tried to come together to get a colour standard but that's mainly for paper printing and so these colour profiles which will be .icc files which you'll find are already embedded in your Photoshop file they're set up for paper printing, but what I'd like to try and do is customise them so you can have one that is a colour profile that would work for linen if you're printing on linen and one for that would work if you're printing on silk and that people could embed into their designs and when they send it off to a digital print bureau it should come out a bit better or match a bit more as they expect but I've got to work out how I do that first.
Emma: Yeah
Becky: Basically the calibration process is looking at your particular print environment so your lap top your software and then the way, whichever printer you choose to print it through and try and maintain the colour through all those different variables so your computer will be set up differently to mine so its trying to keep a constant in that print environment so the colours don't go through too many changes.
Emma: Yeah definitely but if you're always looking at the same screen if you can make sure that my screen is the same as your screen because we're both textile designers then that would be helpful wouldn't it.
Becky: The problem is that there are so many variables involved in that you know when you its difficult to control them all but if you can have a bit more information about each of the variables so that you can try and control it or at least you know what will happen because you're printing on linen and that will look different to silk then your expectations will be managed so

therefore you'll know it will come out more purple so you'll make adjustments in your design to start off with or you wont be so disappointed when you get it back because you know that it that's what it will look like I suppose that's part of it as well is giving people information about it all so that when it comes back they go right well I know I can say to my customer this is going to be a really purple design because of the way it will be printed and therefore people will be just right ok that's what we'll go with or not go with it because they don't want purple.
Emma: Its so silly because if every colour has a RGB value and it is made up by a mathematical formula, then that is the colour, that is the colour it should be, and its just the translation from screen to your eye is lying. That's where you get change, I don't know I'm getting a bit confused but your monitor should not lie to you and then by the time that colour is on the fabric the translation between the ink and the screen
Becky: I think you've totally got it you've hit the nail on the head, is that what you're seeing is very subjective and personal to you so even your gender will affect how you see colour in the first place so how you look at something and how somebody who is older than you look at something will be completely different because your eyes age and your colour changes so its all crazy.
Emma: This colour its orange right (holds up a paint tube to screen) its written red you can see the actual inside its orange, so there was this colour which was more red than this but everyone said its orange, its orange but I'm the colour expert I know that's red with an orange undertone but I felt argued down so I finally admitted its orange. But I know its red but this is called red it comes out red but everyone else calls it orange its quite funny
[41.29]
Becky: There's this artist called Josef Albers and he was working in the 60s and he was saying if you say the colour red to someone to a room full of 50 people you can be guaranteed that everyone of them will be thinking of a different red.
Emma: Oh really
Becky: Colour is totally personal so you will always be right because its your own personal opinion. If you had a couple of glasses of wine the night before that will affect how the colour appears to you as well
Emma: Oh really. That's interesting isn't it. Definitely
Becky: Oh Emma thank you so much for speaking to me and I'll keep in touch and thank you for chopping and changing around because I know we've been trying to set this up and
Emma: I know I'm sorry
Becky: Oh no no I'm also struggling because I can only do Thursdays at the moment with Freddie so yeah thank you for your patience and we got there in the end.
Emma: No honestly I keep on messaging and then you message me and I'm like this IS going to happen.
Becky: Well I'm talking to Melissa Ougham tonight she's working for Sanderson at the moment. So yeah I'm going to speak to her this evening. So yeah I went to TexPrint just with the view of talking to people but its been great because I've made some really nice connections. Did you find that they were all really friendly?
Emma: So in London yes but in Paris no, in Italy definitely. Paris everyone wanted to go out drinking the first night and I didn't because I had to stick on my labels and hadn't finished my work and then everyone hated me because I didn't want to go out with them and then on the train on the way back and it was like oh you have to go and sit somewhere else and I was like ok. It was quite weird and competitive a bit. Everyone was under pressure. But Italy was amazing.
Becky I'm hoping to speak to Isla soon who is down in Falmouth

Emma: Oh she is so sweet and she was at Manchester with me she is lovely. She did really well at Paris. So you'll hear a different side of Paris from her than from me
Becky: Well her designs are very traditional and quite safe in some ways.
Emma: They're beautiful. She was next to Mel and Mel had a really bad time.
Becky: Well that's interesting. Let's keep in touch and I'll send you through those things. Good luck with murals I hope you get all 8 done
Emma: I'm through to the last 4 so I've done some sketches but I don't think I'll be picked it was just good to see where it goes. Thank you!
Becky: I really liked your work I thought it was really you know it was really different I loved the colours I loved the neons I thought that all worked really well I definitely see myself wearing the fabrics you designed so
Emma: I don't think I'd wear any of them. They're meant to be single parts for something else. We'll see I feel like I start off big and then layer it down somewhere which is good.
Becky: I wish you all the luck in the world I think you'll do well.
Emma: Thank you very much
Becky: Ok take care Emma, Bye
Emma: Thanks Bye

Studio Flock- Design Studio

Interviewee: Jenny Wingfield from Studio Flock
Interviewer: Becky Gooby
Date of Interview: 6th March 2017
Method of Interview: Audio Call
Consent given: Yes
Transcript approved: Yes
Recording in Jenny Wingfield.WMA

Duration 30 minutes

Summary
They digitally print their fabrics with Standfast and Barracks using three base fabrics, keeping certain patterns on certain cloths to retain a particular look but customers can specify a fabric if they have a preference. [4.56] [19.14]

Wingfield often suggests an initial colour palette which, as the designers she works with are primarily from a graphics background, they find an exciting challenge. Working in Adobe Photoshop Wingfield will carry out the colour editing herself as she has a sense of which colours will be successful and so that the pattern fits the collection. She sometimes uses Pantone references when working with her printer but frequently sends them just the CAD file. The designs will then be printed for colour sampling, which she obtains at a discounted rate, before final prints are made. [8.33] [19.14] [23.00]

She doesn't use Pantone but feels that some sort of system that showed how colours were expected to appear would be useful or which colours to avoid. [24.51] [26.57]

Studio Flock are branching out into wallpaper so will be required to match designs across paper and fabric. Wallpaper printers charge for colour samples. They also do rugs and she has to translate the colours from digital into the different dyed fibres. [6.09]

Wingfield's experience is that the substrate can have a huge affect on the colour. She has worked with 100% linen, linen mixes and silks because they are all suitable for upholstery. When a previous printer changed geographical locations they experienced an issue with the colours of the final prints on a linen cloth trialled previously. The colour change was blamed on the weave of the cloth by the printer, which was different to the previous batch. However the change of location and therefore humidity and temperature in which the printing process was carried out may also have been an issue. Additionally the printer, if transported or upgraded, may have affected the print colour. The CAD file wasn't in colour separations so a lot of work had to be carried out to select different colours in the design, which weren't printed as expected, costing time which the print bureau paid for. [11.32] [14.35]

Wingfield herself was not aware of standard colour management practices such as colour profiles or colour modes and relies on the relationship with her printers to get the colours as she'd like them to be. [8.33] [9.39]

Studio Flock sell their fabrics and products online, at trade shows (TentLonon, ICFF New York) as well as through high end retailers such as Liberty London.

About
Jenny Wingfield
Creative Director - Studio Flock
http://www.flock.org.uk/
https://www.instagram.com/studioflock/

Studio Flock is a textile design studio which commissions designs for interiors. Starting in 2013, Studio Flock works with new graduates to create contemporary collections of fabrics and products, maintaining a flexible business model so that they don't feel 'forced into being a specific thing or having to have a certain collection at a specific time'.

Transcription of conversation with Jenny Wingfield from Studio Flock

General conversation between Becky and Jenny about dogs, babies and how Becky came across Studio Flock

Jenny: Its me kind of full time and the designers that we work with I've developed a good relationship with along the way and I work really closely with the printers too so it's a quite a nice way of working.
Becky: Its growing and growing isn't it from what I see on Instagram and who you're working with, its gone from producing fabrics to producing products, is that right?
Jenny: Yeah exactly it kind of grows and edits as it needs to I suppose. Quite a lot of the products come from people requesting different things and that's how it happens with that really, but yeah it can kind of be what it needs to be and keep kind of changing as it goes along
Becky: Great that means you can respond to business needs and so forth
Jenny: Yeah absolutely, and I don't feel forced into being a specific thing or having to have a certain collection at a specific time
Becky: Who are you using to print your fabrics at the moment
Jenny: So we print with Standfast, do you know those guys? They're amazing and they're really good although they had this horrendous flood back in 2015, you remember those storms we had at that time of year? The mill runs along the river, the river just burst, and Lancaster is like this little bowl
Becky: And it just filled up?
Jenny: Yeah, and basically the whole business was completely flooded and was under water.
Becky: What a nightmare for them, because I met them at Tent London, and I enquired about doing some screen printing with them, rotary printing, ages ago, but it was beyond my budget at that time
Jenny: Yeah I think its quite expensive to print that way, but that's why digital is so great, its so affordable and you can do small amounts. So basically they've been recovering from that, but its great because they've bought all new machinery and they've got amazing digital printers that can do huge capacity now, so its been quite good for us.

Becky: Because the technology is moving so quickly isn't it. When I first started digitally printing in 2008, it was still kind of very very new and now people are beginning to get machines that do all the secondary processes themselves, its great. I think its going to get a bigger share of the market as it gets faster
Jenny: Definitely yeah, well I was speaking to Standfast about this because I did a talk at HeimTex this year about this and about trends and talking about digital printing, and I was asking how much of their business is digital and they said its at least a third which is amazing because like you said its only really since 2008 that anyone started using it so its grown really quickly. And its just fun because you can be really frivolous with your patterns scale and colour. I think its great
[4.56]
Becky: Yeah cos the designers that you use, especially Rachel Parker's designs, Pixel Thread, her designs have all those lovely translucencies and colours, it would be quite difficult to achieve some of those traditionally
Jenny: Definitely difficult to achieve and unaffordable with all the colours you'd need to do. We recently translated the design into a rug and had to reduce it down from 100s of colours into 26 I think it was, which is still a vast amount for a rug I think. It was a really hard challenge.
Becky: So do you do that yourself, or do you send it back to Rachel and say this is what the manufacturer needs?
Jenny: I send it back to Rachel for that particular thing because I want her to feel comfortable with how it looks because its her domain, and if I took out a colour that she really liked then it wouldn't' be her design anymore.
[6.09]
I generally do colour editing so if I find a design that I like and I think it should be in a certain colour then I would do that if the designer is fine with that. But yeah with that particular one I wanted her to feel like it was still her design
Becky: And when you get the fabrics back from Standfast do you get the designers to vet them or is it totally, once they've handed over the design to you its all down to your eye?
Jenny: A bit of both really I would normally meet up with the designer and say this is what's come back and say what do you think, what do you like, and get their opinion but then I guess the final say is with me but its quite nice for them to see what they think and if that's how they'd imagined it to come through and then sometimes I suggest a colour palette at the beginning, so if a designs quite loose in its form and not quite finished yet, then I might suggest a colour palette to finish it whilst the design is being edited and that's quite a nice way of working as well but its so hard because it just looks very difficult from print to screen to paper to cloth.
Becky: They all look so different don't they
Jenny: Yeah really different
Becky: And with your colour palettes are you using Pantone as a reference or are you sending them colour palettes in Photoshop or
Jenny: Normally just colours in Photoshop. I have sorted of started, because that's how I normally work but recently I have gone back the other way round to use colours that I like with Pantone references and bring those into the design but normally sending it straight from Photoshop files and that seems to work well with the printers
Becky: Do they give you a colour profile, do Standfast give you a colour profile or do they suggest a colour profile that you should embed to make sure you do get the colours you're expecting?
[8.33]

Jenny: No they don't actually, that would be quite helpful. Is that normal?
Becky: Well it doesn't seem to be normal in textiles but that's what paper printers do. They say could you please use this profile because that works best with our machine, because the profile is the bit that controls the print environment, it makes sure that the colours take into account what sort of substrate, whether it's a matt or glossy paper, and whether the printer is using cyan, magenta, yellow, black but perhaps with red or green, orange or purple involved, but I haven't come across any textile printers who are doing that yet and I'm just kind of interested why they're not. Because at uni we use AVA and they have set up profiles that the computer will read through AVA and it's a different profile depending on whether its wool or silk or linen or cotton
Jenny: Oh Wow. Gosh that's amazing
[9.39]
Becky: Yeah it just seems to take into account that the weave will be different and that the way it is coated is different
Jenny: and would that be, I mean its still a guide because I guess it would still look different on everybody's screen because not everyone's calibrated
Becky: Yes absolutely yeah
Jenny but its much closer than normally
Becky: Yes so I don't know whether you've come across it when you've done your printing but when I've printed on silks when it comes back everything is really really vibrant so I've had to tone the colours down in the design, or if I've printed on linen everything's come back quite faded and washed out so I've had to darken all the colours in the design so these profiles are meant to take into account that this happens so you don't have to adjust the design so much
Jenny: Ah yeah that would be so useful, we've had those problems with one design and we were printing it with , we've got one design that we were printing with [Redacted DPB C] and they recently moved to Thailand and they started using a different print linen, so it's a linen, its still 100% linen but it really changed the colours, just from this new kind of weave basically that's all they could describe it as, a different density of cloth, it was still 100% linen it looked so different it just suddenly lost all its colour. So it was a real problem and that particular design wasn't separated so it was quite hard to isolate certain colours to try and bring them back up again.
[11.32]
That would be really helpful that profile, is that like a software that you just buy, like you buy Photoshop
Becky: So AVA CAD CAM they're called, I'll send you their website, they are a specifically developed design program for textiles for textile design and they have developed their colour management part of the software to really work with digitally printed software but also to separate the colour ways so that you can then take it into screen printing or rotary printing if you wanted to. But they are so expensive that they're only, its only the big companies that can afford them so most freelance designers don't use them and most small businesses don't use them, because they're just too expensive but we have them at uni and I think you know Mulberry and Liberty and people use them. It's a nice program but if its too expensive then..
Jenny: In a way it's a bit tricky because you kind of don't want to become reliant on it because then when you go into the world working and you don't have that then
Becky: No exactly, let me just, I've got a very tearful toddler in the background, I don't know if you can hear him
Do you have any problems with colour consistency then, you've talked about the linen but have you had any other issues.

Jenny: Not particularly, do you mean through different print runs. No actually we've been quite lucky with that.
[13.22]
The only one that we had a problem with was just this move to Thailand, the printers told me it was because of the cloth but I don't know whether it was because they used different machines as well which they will be so no that was kind of the only issue but it was a big issue and the main issue was that the majority of that particular design was orange and because the orange was so faded it gave the overall look quite a faded look in the end so yeah it was quite a problem but I think we're there now and they covered the cost of separating it. Well I mean I kind of thought they should really because it was never a problem and it was there decision to move all the printing and that suddenly changed it so it wasn't like it was anything we'd really done so I think we're back on track with it and its all separated now, god knows how much time that took,
Becky: Do you tend to stick with linens then or are you doing a range of fabrics?
[14.35]
I suppose it depends on the end use
Jenny: Yeah well this is the thing, I thought we'd do fabrics which would work with upholstery and for soft furnishings so I do consider fabrics that will work for them and colour and scale that will work for both of those so we started with 100% linen just because we could get a really lovely bright white one and then its handle is really nice and now we've started using a linen cotton nylon mix which is really good for upholstery and then there's also viscose linen in the collection as well which has a lovely sheen to it, its got a really nice texture and sheen and the colours on that look really different, it must be similar to what you say about the silk, it becomes a lot more vivid. Bounces the light a bit more
Three fabrics, three base cloths and we kind of keep certain patterns on certain cloths because I like the way they look but its possible for a customer to specify what they want so if they wanted a design on a certain cloth then that's ok as well
Becky and do the are the fabrics all sourced by Standfast. Do you source the fabrics or are they sourced by the printers?
Jenny They're from the printers yes they provide, they've got a really good range actually, they've got a good selection of cloths in their collection
Becky: I've been looking at Contrado who have got an amazing range of fabrics that you can print upon including wetsuit fabric but I think they do that through heat sublimation printing rather than inkjet but its fascinating how wide the range has become and how versatile you can now be in digital print
Jenny: yeah and I think its really exciting now you can do sort of outdoor fabrics digitally which you can never really do and that seems to be becoming quite a thing and you see more printers offering that now recently, so yeah, Contrado do they do the printing as well or do they provide the base cloth?
Becky: No they do digital printing as well and they do a sample kit where they send you every single fabric that they do and they send it already pre printed with a pattern so you can see colour variations. So I thought that was quite good, they seem to be based across Europe but they're a bit like Spoon Flower you know the big American company they churn it out. I don't think you'd get as good customer service as you probably do as a business with Standfast,
Jenny: Do they have their own range as well, do they print their own designs too?
Becky: Yes I expect they probably do, they probably have designs that you can mock up, I think they're associated with bags of love, you know where you can print your own shopping bags.

Jenny: Oh yes do your own thing. Have you seen print all over me? Have you seen that company? They're really cool you can sort of, they just have a massive range of fashion and accessories and all sorts of stuff that you can just literally get a template of a rucksack or a dress or whatever and just put your design on it, quite cool
Becky: I have been talking to RedBubble who are based in America and Australia and they have a bank of artists and then you say ok I like that design and I want it on leggings and Redbubble will print it for you and send it out or if you want it on an iphone case or a duvet so its obviously something that has a big market
Jenny: Yeah there's so much more of that now, there really is and just like smaller companies do you know BeFab? They're based in Scotland, so I think companies like that are great because students who are literally just wanting a metre can do it, its so accessible, it helps when you finish uni to maybe get your own collection launched, keep your own portfolio going, rather than having massive minimum order that makes it impossible to get going when you first start [19.14]
Becky: Do you design yourself as well Jenny?
Jenny: No I'm actually currently doing a course to learn how to do it because I didn't train in that at all so I'm quite interested to know what I would create if I put my mind to it, I'm kind of sort of doing a little bit of it just with colour and scale, currently I've got some kind of thoughts of what it should look like. So no, I'm teaching myself at the moment
Becky: Are you using Photoshop?
Jenny: Yes, it's a course with the fashion and textiles museum.
Becky: I was just there to see the Josef Frank
Jenny: Oh my god its amazing isn't it
Becky: I know its lovely
Jenny: Its really good yeah it's a really good show
Becky: And its really well curated, I've seen some stuff there that has been a bit stiff looking but I thought it was really nicely curated
Jenny: I think it was just lovely because its quite a luxurious show because they could choose these big lovely long lengths and that's all you need so yeah its really good I love all his designs
Becky: We went to Vienna last year and the Museum of Applied Arts, like the V&A but in Vienna, have their restaurant is entirely upholstered in Josef Frank fabrics
Jenny: That sounds amazing, what's its name again I'll look it up
Becky: Its called MAK, It's a nice museum
Jenny: Ah good
Becky: That kind of is all the questions I've written down really. So it sounds like the, because you're using good printers they're helping you out with colour trialling to get the colours as you wish and that you're involving the designers to make sure everyone is happy with the look of the colour and consistency has been ok, apart from the random linen change, so but would, because what I'm looking to do is try and produce a website that gave companies like yourself but also freelance designers, information about digital print process so that you felt informed about it then you could know how to control it or what to expect from it. But also to produce things like colour profiles that perhaps you could download for a linen print as opposed to a silk print but I'm also looking at Pantone colours because actually 1/5 of those are not printable, you're not able to print them using ink jet inks because of the colour mixing so I'm trying to work out, put together a book of those colours at the moment and work out how you can apply things to your design so it would darken the colours that you can't print because the printable version would be a darker or greyer version so you could see how it looks on the screen

Jenny: Yeah, that's a really good, because you get that slightly especially when you choose a colour in Photoshop it shows you that's going to be like this, it doesn't really help because it doesn't actually show it in the design. And so what do people do with that, I guess textile designers don't really design in Pantone or do they?
[23.00]
Becky: So I've been speaking to a number of designers and at the moment most of them want to remain anonymous because they don't want to give away their secrets which is quite interesting, but lots of people have said through experience they know that yellow on linen in a particular way so they adjust the saturation in the design, or they make changes to the levels in the design so that, they can see on the screen what it will look like when it is printed and they work that way. Or that they use Pantone references and they start off with the colour palette and they've already tested all those colours to make sure they're printable and only choose colours from that colour palette and so that kind of makes printing things like photographic imagery or scans of hand drawn things that makes difficult because obviously they're not contained in that tested colour palette so it seems to be quite experimental at the moment nobody seems to have the same method of working so I think what I'm going to try and do is explore some of those methods and put them up there on the website and then people can use the results from those if they so wish see what is most helpful. It seems as though some people its just through experience, doing it again and again, their knowledge, how it works and therefore they, they couldn't explain the process to you because its become almost like driving, its just become second nature, you know its like an additional sense to them, they can't write it down any longer
Jenny: Interesting
Becky: Yeah its going to prove tricky to establish exact best practices but I'm going to give it a go.
[24.51]
Jenny: Oh my god well yeah that would be so helpful because I've actually got loads of samples back from the printer this morning, it would just, I'm very lucky because they hardly charge me to do sampling, but if you're with someone who does, and actually I'm thinking of moving into wallpaper, they do charge a lot for sampling with wallpaper, and if you could just really nail it before you'd sent it to sample, and you'd just be really confident with the colours then that would yeah be really helpful, because it just is time wasting and expensive
Becky: Do you think having a website might be something that you would look at or what sort of methods do you find most accessible
Jenny: I'm just trying to think what would be really, because having something that gave you, so you could see the whole thing together with how it would look rather than see individual colours, I don't know how you would do that, but that would be really helpful. I think I'd use, well actually colours come from all sorts of different places. I find that really interesting how the designers choose their colours and whether that's sort of integral to the design because quite often I choose, I quite often use the hue section where you can change, and I find that really interesting because you can change all the colours at the same time rather than just editing out first colours so some kind of like overall thing where you could see the colours together how they're going to look would be really helpful.
[26.57]
Becky: And would you, would you, a colleague of mine who is at Leeds he's developed a colour palette that you incorporate, its like a plug in and you install it into Photoshop and it doesn't allow you to choose colours if they're not printable so you say I'm printing to this printer and I'm going to be using linen and therefore it says right none of these colours are printable so you

can't have them. Unfortunately it was up and running and Leeds university have cut funding to it so its not moved further than Photoshop CS5 so it's a bit out of date he might try and do it again. But do you think as a business that you might work with your designers to say well look that's a lovely design but that's not printable and so you need change that or?
Jenny: Yeah definitely because a lot of my designers that I work with are not from textiles at all so they don't have any knowledge of this and so it could be an embroiderer or graphic designer screen printed so they've not come from a textile world so having a limited palette would be exciting for them because it would be equally out of what they're used to and also it would have a bit of consistency and it would be very useful definitely
Becky: When I was speaking with RedBubble they were saying that they wouldn't want to impose any restrictions on their artists because they'd want them to be as creative as possible but they're having problems with printing the colours so I was just like well you're a bit stuck but I could see what they were saying because obviously the design is really important
Jenny: I find the other way I find my designers are really open to seeing their patterns in all sorts of different colours and they're not too precious about it so that's really good I don't know if that's because they're new and new graduates and be like more open to it and they're still in that student frame of mind of exploration but it doesn't seem to be a problem I've never had anyone be like no it has to be like this
Becky: You're, not the mediator but you're facilitating getting their designs into reality
Jenny: The world
Becky: Yes birthing them, you're like a midwife for designers! Oh well Jenny thank you so much for giving me your time and for speaking to me
Jenny: You're welcome, if anything else comes up just yeah
Becky: Yes please, I'll definitely keep you in the loop with anything that I come up which I think might be useful to you so I'll keep in touch definitely
Jenny: Great thank you very much good luck with everything, sounds like quite a project but I'm sure it will be very very needed so
Becky: I might just come up with a big mess at the end, ok thank you so much for speaking with me and take care have a good rest of your day, bye
Jenny: bye

Bugi Studio – Design Studio

Interviewee: Helle Albild from Studio Bugi
Interviewer: Becky Gooby
Date of Interview: 9th February 2017
Method of Interview: Audio Call
Consent given: Yes
Transcript approved: Yes
Recording in Helle Albid.WMA

Duration 40 minutes

Summary

I encountered Helle's work in a paper by Cathy Treadway and approached her for an interview. [1.40] She is very interested in colour and digital print and has extensive experience from working for companies in the US in the late 90s when digital print started to be used in industry. She produced a report, in Danish, on colour issues in digital textile printing in 2002 after encountering problems in industry, to establish which colours were printable and utilised design software, potentially NedGraphics, that flagged whether a colour was out of gamut or not. [5.16] [8.18] She has seen the changes that the textile industry has undergone to incorporate digital textile printing and design and has been frustrated by how long it has taken. [16.29]

In addition to her industry experience, Albid has taught in higher education for over 10 years. She got the students to print a range of hues, from light to dark, to compare the printed colour to the screen colour. These experiments extended to different substrates and printer settings so that students could see the differences these made and got into the habit of saving the settings so they could achieved the colours they desired. [8.18]

Albid creates her own colour samples, in addition to using established colour referencing system such as Pantone [12.39], which she prints onto Epson Heavy Matt paper using her own Epson dye sublimation T-shirt printer. She regularly calibrates her print environment and prints across a range of substrates (ceramics, t-shirts, fabric). She designs in Illustrator or Photoshop [22.08]

At a visit to the print trade show ITMA, Albid was given a colour profile by Epson which she continues to use as achieves the best colour match for her set up. [10.45] She has had issues with printing white, which is possible in pigment printing, because the printing pigment has dried out and clogged up the printer heads so she avoids using white. [29.15]

Albid pre-treats her t-shirts with a liquid coating which she rollers onto the cotton to achieve brighter colours. However she'd like to source pre-treated t-shirts as applying these pre-treatments without access to a spray booth and a larger studio space makes this procedure difficult. Albid has also experimented with double pass printing to achieve brighter colours. Albid's designs for Bugi Studio range from monochrome line drawings or text (black on substrate), coloured dots (spinkels) arranged in shapes, and monochrome photographic images. One of her most popular designs are her colour charts printed onto cushions. In addition to her online shop, Albid has recently set up her own boutique in Copenhagen and sells her designs through a number of outlets as well as running educational workshops for children. Albid feels

that to be successful she has to have a broad skill set, managing her website, marketing (social media) and production which she finds time consuming. [32.39]
We discussed how digital has enabled her to sell products differently, via other retailers, but that has brought frustrations with payment and not being able to scale up. [32.39]

About
Helle Albid
Bugi Studio
https://www.instagram.com/BUGIstudio/
https://bugistudio.com/
https://digitaltextileprintingblog.wordpress.com/2016/09/26/practitioners-helle-abild/

Helle Albid is a Danish designer who runs her own studio and shop in Denmark. She has worked extensively across industry, particularly in the USA, working for large brands such as Levis.

Transcription of conversation with Helle Albid

General conversation between becky and helle a
Helle: Is that better
Becky: Yes much better thank you
Helle: Ok its because I have my computer and the docking station on the floor
Becky: Ah I see
Helle: the microphone is in the computer
Becky: Is that at your beautiful desk which you sent the picture from Facebook, very nice
Thank you very much for speaking to me and I'm sorry I wasn't very good at communicating why I wanted to speak to you
Helle: I probably didn't really read the email, it was probably me
Becky: Well really as I tried to explain in the email I know that I as a designer have had problems with digital colour and what I have to do is establish that how other designers are working to see if other people are having problems or if its just me if you see what I mean. So I came across your work as I said through Cathy Treadway who was writing about people using digital textile printing in a really interesting way and she had heard you speak in Philadelphia and she saw your piece of work I believe its called Transatlantic Transformation where you were using patterns that looked like they should repeat but they were distorted and didn't quite repeat? [1.40]
Helle: No that wasn't the point I made it was more, because I was living in the US, I called it Transatlantic Transformation and it went from Mickey Ears to Viking Helmets so it was morphing in colours and shapes.
Becky: Yes, yes so she's written about it as, that your someone who is exploiting the idea that you don't have to use a repeat pattern any longer
Helle; It wasn't a repeat pattern, it was 3 metres in width so it was big files
Becky: And that time, that would have been in 2006 so a good 10 years ago, at that time had you set up Bugi Studio or is that a more recent development?
Helle: That's a more recent development. I had another workshop everything was customised for kids and then the one I have now is more kitchen but I opened two years ago when I quit my job, I was teaching at a design college. I was doing everything there, digital printing and they had Mimaki printers. It was many years ago.

Becky: And you sent me some images where you'd got some prints in India. So I'd been under the impression that you had your own Epson printer from what I'd seen on Instagram. Do you print in house, do you print your things or are you going to be looking to outsource that to somewhere cheaper?
Helle: I do have an Epson sublimation printer I do have an Epson t-shirt printer which I use for everything else.
Becky: Because I've recently been experimenting with layering where I've been printing an image and then putting it back through the Mimaki to print a second layer of ink so that you get overlapping colours and I'd seen you'd been doing that on Instagram as well
Helle: Yes, where I print them but that's on a plane so its quite easy.
Becky: Its quite tricky lining up the pattern so the printer is in the right place
Helle: I think that must be impossible. You can kind of be an expert.
Becky: It was nice because the pattern was in yellow and blue but it came out in yellow blue and green because where the inks crossed over they created a new colour which is something you don't normally get with digital printing so it was an interesting thing to do. So my PhD is looking at colour and how designers can have more control over what they expect the colour to come out like because when you're looking at the screen obviously the colours are made up from light but when you print it the colours the colours are made from dyes or inks so the colour gamuts don't match each other so some of the colours don't come out as expected. Is that something you've had issues with or have you got colour management software that resolves it for you
[5.16]
Helle: No not at all I have worked with colours for many years and I lived in the US for ten years and I did research in 2001 / 2 and I visited a lot of places in the US. They had software at that time that put warnings on the screen if colours were not possible to print. But then I worked with colours for years and also when I lived in New York and San Francisco there we printed out colour charts so then we knew how it printed out because we saw from the print outs. Which is basically how I still work. So when I get samples, these from India, the colour charts I have and its often how I do and also with my sublimation and the other printer I keep the colour that looks better when it comes out from the printer. And that's what I taught all the students for over 10 years because no I don't believe in it, and the students each have different computers so it's a very good practice for them I normally start with them, for a week, as part of a 6 week computer course, and then they told to get 1 a4 and 1 a3 sheet and do colours, and not just one red, do a couple of reds, and then they would start for the first day they would do that and then we printed it out and they could see how the printed colours were different
Becky: So your practice is to by trial and error and experiment and experience to build up a knowledge inside your head as well as having this sheet of colour swatches
Helle: Yeah because at the college we would print samples with three different settings on the printer and on different qualities so when they print and they look at the silk and say ok I want this red to be darker and then of course and the important thing is and I sometimes forget myself is the need to have the same settings when you save it.
Becky: And do you do things like creating customer colour profiles for your prints so that you've saved those settings?
[8.18]
Helle: No I was going to do, I went down that, its probably what you've seen because I haven't been so good on Instagram but I went to a high quality printer and he had the reader, the spectrophotometer, I can't say that word
Becky: I know its an awful word

Helle: And I was going to do that make a profile but I don't know what happened. But I don't know what happened, it didn't work, we thought it would be possible but I wanted to locate the colour profiles on that Epson T-shirt printer, as I had to print it two times to get the intensity I wanted. That can happen on linen the fabric gets a little wet and it moves so I wasn't all happy with that. But I went to ITMA, last year of the year before, time flies, in Italy you were probably there too I guess, and I spoke to an Italian guy on the Epson booth, and he had a profile that I got from him and it actually works really good with just printing one time, it doesn't work if you want to a photo because its kind of brightening the colour but when I do graphics things I think its pretty good, its intense but good
Becky: So yes that was the other thing I was going to say, with the colour swatches when you're knowing the colours this red will print but this red will not print that doesn't take into account a photograph because its made up of so many tones but I noticed
Helle: But I guess the profile I have for the Epson it kind of has that saturated contrasted because I forgot I was doing this custom profile I printed a photo and it looked awful there I can use a normal profile and then it looks alright. But it was just a favour for a friend, a one off.
[10.45]
Becky: So you don't use like a colour referencing system like pantone, you've done your own colours?
Helle: I do have Pantone but I do have the big swatches in a suitcase with all of them but I never really use it except I love looking at it. I think I guess I wasn't I did some work for a company and because there was time and it was easier for me to sample I always use Epson Heavy Matt paper so its easier for me to print out the references myself the colours I wanted and send it because there was time for that except the printer blocked some of the colours that were in the design.
Becky: So with the, cos I've seen that you also design lampshades that you sell through other retailers. Do you have much control over how the colours come out with these?
Helle: Yes, that's the ones. I designed those for a company, a Danish company, and that's where I did just send them, it was easier to just send them the Pantone reference.
Becky: And they were happy with that, they were happy to just use your references?
Helle: Yeah I never heard anything. I think they did it pretty much as I wanted it
Becky: That's good. And going back to the research that you said you did in 2002 in America, was that published anywhere or was that specifically for the
Helle: Yes, it was but its in Danish.
Becky: Ah my Danish is not very good
[12.39]
Helle: I did that, but I've seen, I can see now I sent the files to India and I don't know also the fabric and he hasn't the things he has sent me back he has printed in several ways so he has also done original 1 2 and 2 different settings which makes the colours very different
Becky: Ok and so you then select which particular way you like best you say this setting is the best one for me
Helle: Yeah sure I've sent colours because then I don't know yet if I want to do its just right now things are too expensive to see I cannot sell it wholesale because I had the pillows made in Eastern Europe of course not that expensive but its not its I can't sell it to a store that adds like three times so my set up I couldn't do I couldn't do 3000 different pillows so I was looking at different options my first job was all custom made I can't do things like that too but I want more and more away from that because that's what I want to do but I could never hand out to someone else for production because it was all one offs. I think the idea is brilliant but I don't know I'm still a little ambivalent because I do like printing and doing stuff but on the other hand I don't want to spend my whole life being a production

Becky: understand that but do you think that digital print that particular process has allowed you take more control over your design work in that you can get it printed and you can be in a bit more control
Helle: Yeah I think I think in general the whole digital design process because I remember when I lived in the US I also worked in the contract market and people were like oh its ruining the design patterns but I don't think so because it made things so much simpler to actually test things and change them because we didn't have to sit and draw the print by hand I was buyer for that company I was teaching all my co-workers how to use the computers and I remember in the beginning I know it myself when something was new they were like oh no its much to fast but no none of them would ever do that again but it was so fast you could send it to the mill and they would weave a sample and it didn't work with this line so you could change it and you'd get a sample the next day and that I think opened it up to creativity and experiment and a lot of people were so scared and oh its ruining the whole process but I don't think so
[16.29]
Becky People don't like change
Helle: Especially not textiles people, oh no I think at first digital samples were printed in 1999 or 1998 its taken forever. But I remember I went to a job interview at Levis in San Francisco and they had all at that time the newest equipment and they could do printing that could look like gouache so they did the designs on the computer and they printed them out and then they had to sit and hand paint then afterwards because their merchandisers wanted the hand printed but didn't want to talk about digital printers. Its been slow because for many years they didn't' want to buy, when you sell designs they had to be hand painted because oh they could be copied and blah blah blah and even now they expect them to be in a repeat on the CD right, but its been a long slow process
Becky: Yeah that's really interesting to hear because I only started designing in 2008 so and digital print there was only 3 or 4 companies in the UK at that time who would do the digital printing so I've seen it change in the almost 10 years but it sounds like its taken quite a long time to evolve to the state its in now.
Helle: the Transatlantic Transformation, I think that was in 2002 I had that printed by [Redacted DPB B]. I went there I stayed in a little sheep farm
Becky: In Macclesfield?
Helle: Yeah in Macclesfield
Becky: Nice so I've spoken with them because they supply most of the universities in the UK with their printers and so forth but lots of people are having lots of issues with them because they feel that they are not paying enough attention to detail and their machines are not working very well, they tend to say well it doesn't print very good colours but you have to accept that.
Helle: But they don't have a print section any more I'm looking at the web page right now they used to have a whole digital print place and then on the other side of the yard they had a traditional textile printing mill but that's gone. She left for Ireland who was running that, they did all the cool techniques and screen printing. – IS THIS TRISH BELFORD?
Becky: They set up their own colour management system called Smart print that they developed but lots of people are having issues with that and saying that's not very good so they're moving to a software called AVA I don't know if you've heard of them
Helle: Yeah, they've been around for years doing these repeat programs but I always do repeats and stuff in Photoshop and Illustrator, I love Illustrator, I think it's the coolest program. But I know AVA, I used VL and AVA and they were also at ITMA.
Becky: So AVA feel their Colour sync program that they've developed is the bees knees it will be, they feel that solves all colour issues and it can overcome most of the colour problems that

people have, so I'm investigating that at the moment but its very expensive for a freelancer to afford it its almost out of their price range I think sadly
Helle: maybe I just never understood it when I talk to my guy who I bought my printer from he services big corporations here with colour management and I just don't believe in it so that's why I'm doing print out the colour charts and choose from that
Becky: Well I spoke to Dr Phillip Henry who developed a plug in for Adobe called Colour Mimix where it restricts you to only being able to choose colours that are in gamut for your printer and he said like you that that is the best way so knowing which colours will print and having your own palette which you know you can achieve those colours he feels that's the only way it can work like you he doesn't really believe in colour management software either so you are not alone
Helle: ok that's nice to hear
[22.08]
Becky: So let me look at my questions see if there was anything else I was meant to ask you. Oh yes so the white ink that you printed with is that a pigment ink and is that just in sublimation printing
Helle: In sublimation you can't print white, you know sublimation goes into the fibre and it becomes at 200 degrees Celsius it becomes a gas and it becomes part of the fibre. So you cannot print white same as reactives you can't print white. No this is Epson T-shirt printer is a pigment printer
Becky: Ok so that's why it can print white
Helle: the whole Idea with the white, I have taken it out now, I used to have another printer before that that always clogged up it was called Texsomething. And it was hopeless and it always in the end the print heads got and the I got a new printer with the insurance and I got this Epson and its pretty good at not clogging but you need to run a clean cycle at least once a week or every second week if you don't use it and its really expensive the ink the big issue right because I think one ink cartridge is £140-150 so its like money out the window if you don't use it and I don't right now I'm not really using the printer very much so I've taken it out because it doesn't make sense so I was just 3 weeks in India and gone all summer and then you know its fine when the white is not in it doesn't clog up but the white is very, you have to take it out and shake it and make it print a little print sample but that's so much better than before then it would clog up in one day where I think I've had this for two weeks and it be ok and I've taken it out but the idea with the white of course when you print on a black t-shirt it starts with printing a whole white underneath and then you print the colour on top of it. The weird thing is, what I don't understand because I am very interested in colours when I print on a white t-shirt I print some colour sand I don't think they are good enough and I have to print it two times but then when I print on the white it has pre-printed it looks perfect and I think is that the white doing it or is it doing a different colour profile which I think it is I think its doing a different and its been a big question I think its doing a different colour profile when its set to print on a black t-shirt and it knows it will have the white underneath
Becky: So maybe it brightens the colours because it knows its being printed on a black substrate so it needs to be
Helle: No its not a black substrate because it prints this white surface
Becky Could it be because it's a white surface of ink rather than fabric could it be the way it reflects back
Helle: It could be and also you can get better colours if you pre-treat a white t-shirt just with some liquid. The thing is that's why it gets a little when you print with the white ink you need to pre-treat the t-shirt with this liquid so if you don't have a spray booth you have to roll it on and

dry it, its heavier and it sinks better the pigment sinks down so you need to kind of close it with this pre-treatment and that closes it and so you need to either it gets a little more complex and you need more space more this and that or send it out and still, some t-shirts companies wanted to start delivering pre-treated t-shirts because that would make it easier for small companies so

Becky: Because I'm going to be experimenting with making my own coatings for fabrics because the research that I've been reading has been saying that the way the fabric is coated really affects the colour so I'm hoping to do some experiments with its made up of things like cow's urine and other funny kind of chemicals so I'll see how I get on, if I get some interesting things I'll send you pictures

Helle: But I mean the normal, but your'e talking about pre-treatments for reactive dyes but that is what I don't know I originally a screen textile designer and was trained with screen printing so the pre-treatment is used in the colours before and has the chemicals and the algy things to make the fabric more stiff and then yeah you have the urine liquid its not in print but its in coating liquid. But for pigment its complexly different you have something called armour. I think Epson (https://www.epson.co.uk/products/consumables/ink/pre-treatment-liquid-20l-c13t736100) is pretty good its pre-treatment. Ive used it on I put it on a polyester and I could print it with pigment. Normally I print polyester with sublimation but I was just curious to see what happened with the printer because I heard that this armour (http://imagearmorpt.com/image-armor-ultra/) pre-treatment I bought it in Germany and that worked fine but also Epsons so you could print on a polyester shirt with the pigment and then it flows

Becky: So it was more to do with the way the surface or is it to do with how its washability afterwards

Helle: No you couldn't print at all it would just flow it would look awful but it looked fine surprisingly fine which I had not expected

[29.15]

Becky: Yeah because I'd understood that pigment inks were the way the industry wanted to move because pigments require less pre-treatments and after treatments even though the colours can sometimes be not as vibrant as the reactive and acid dyes

Helle: Yes of course they will not be the same, its cannot because it the pigments are on top and the others are in the fibre and no binder so it will always be different

Becky : But you were saying they dry out quite quickly that's the problem that people have been having with them they dry out quite a lot and they clog up the machine the print heads and also cause lots of issues

Helle That's the white ink only I haven't had problems with the others not at all but the white ink

Becky: So its just the white ink

Helle: Because there's like this little rubber thing in the printer and when you clean it it has it needs a service to have the printer back to form

Becky: And is it just you who runs Bugi, you don't have anyone working for you?

Helle no I have my web page and I have been doing freelance projects for my old boss for the last three years so I haven't been doing anything for my web pages, secretly I have right now I have to decide whether I have to do some advertising or SEO search engine things something its not worth it for me as I just had a coaster order this week and a door matt and I had a coaster order and a doormatt last week but I need to get so much so I print one day a week plus I have orders and I don't really want to print for other people, I can't compete with these bigger companies and I don't want to. I have a Summer house on an Island where I designed the logo

so I print for them so I print 50 t-shirts and cups so otherwise I don't really print for other people.
Becky: It sounds like an good set up
Helle: Yeah not if you want to make money.
Becky: And were you doing things with cookery too, very versatile
Helle: Yeah I always liked cooking and I loved taking pictures so I started this food blog and but I'm a bit like with that too time with everything what with facebook Instagram and webpapge. I have the same with the food blog I have another blog about designing products in general and I just completely re-designed and renovated our house I don't know its just I don't know where to start and where to end and nothing happens
[32.39]
Becky: I think that the down side with digital is that you feel you can do everything yourself but you haven't got enough time or energy of yourself to do everything so I'm similar to you I start lots of things and try and put lots of energy and effort into all of it but it becomes too much to keep it all up I think.
Helle: Yeah I think because I know I think it's a pretty good I sometimes go to they have free seminars here so I went to the ad words one and I met this woman who has a web shop with different design products and so I talked to her and she said, I decided I cannot deal with ad words in my head but in her webshop all the products in her webshop if she sold my doormats on her website the order would go to me and I would send it out. So that means that, so she doesn't have to come up with new ideas and print them and pack them and whatever so her whole work is to just maintain the web page the facebook page the Instagram and do ad words but I have to do also come up with new ideas and design them and print them and send them so you know. So then its hard to focus
Becky: There are a lot of companies like that here and often they don't pay you until a couple of months until after you've sent out the order because they take the money and then they don't' pass the money onto you until 2 months so it can take a while to get paid as well.
Helle: So yeah I don't know how she worked but still it I cannot deal with those things but yeah the dilemma is I don't have the money to get someone to do it I do have a web guy that has set up I design my webshop and my blogs but I had him set it up because I cannot deal with that either.
Becky: I agree its hard to be a specialist in all these things. Well Helle its been really good to speak to you. I'm so pleased we got to speak because its been really interesting hearing about your own work and your journey from where you've come from to what you're doing now its really inspiring. So thank you very much I really appreciate it and I don't know I would love to hear more about how it goes with printing in India if you do decide to do that and I would be very happy to keep in touch with you and let you know how my work is going if you're interested to hear about it but yeah I suppose I just want to say thank you for your time really thank you for speaking to me
Helle: Yes you're welcome I don't know if it was any help at all
Becky: No it was it was really good help because
Helle: I probably said all the wrong things
Becky: No you said great things. So I've been speaking to all these software people like AVA and [Redacted DPB B] and also to chemists who are looking at the inks and dyes and also making the coatings and they have been well there is no problem with colour we've solved it our coatings solve this problem you don't need to worry about it or our colour management system will accommodate all the colours and you wont have issues yet I can see sort of with my prints that there are colours that are coming out that are not what I wanted so I was feeling frustrated that

as a designer I don't really understand the chemistry I don't understand the software and these people are saying to me there's no problem but I can see that I have a problem, so its good to talk to somebody who says I don't really believe in the colour management software this is the way that I go about it and this works for me because as a designer I understand that method that you've trialled it you've looked at the colours you've worked out which colours you can use and therefore you work with that palette that makes sense to me whereas sort of chemistry and software design its out of my control so I think ok he says its going to work but it doesn't work so maybe I'm wrong maybe I'm stupid so its good to speak to someone that says this is what works for me and its not a system that somebody else has imposed upon you so it has been very useful

Helle: Ok that's good, any more questions you just have to ask

Becky: Thank you Helle and have a good rest of your day and I wish you very well thank you for speaking to me bye bye

Helle: Bye

Jaqueline Milton- Design Professional

Interviewee: Jacqueline Milton
Interviewer: Becky Gooby
Date of Interview: 1st August 2017
Method of Interview: In person at Jacqueline's house and studio in Dorset
Consent given: Yes
Write up approved: Yes
Recording: No Recording – write up devised from notes made at meeting

Duration 2 and half hours

Summary
Jacqueline's industy experience meant that she had a lot of knowledge of the textile industry and applied professional standards to her practice. She tested and trialled various fabrics, DPBs and created her own colour chart. Additionally she sent her fabrics to the Shirley Institute for finishing tests. She experienced issues with consistency and whilst her experience enabled her to challenge this with the printers, they undermined her so she sought a different print bureau. She uses pigment inks for her printing and was happy with the colours particularly because they work well for flat areas of colour and had better consistency. Her designs could potentially be screen printed but the ability to have short print runs and hold small amounts of stock enabled her to set up her own business. She designs for interiors and works with interior designers, upholsterers and soft furnishing makers, building up her business. She had tried out a few print and sew services but was unhappy with the quality. Her colour chart tested each hue from dark grey to most saturated and was incredibly precise. She would use this as her colour sample test and to trial a DPB or new fabric and then adjust the artwork. She found that DPBs would give a discount for colour sampling.

About
Jaqueline started off her career at Axminster Carpets as designer
Went on to work for variety of companies as a designer working directly and for them as well as freelance roles
She then set out to sell her designs via an agency and has now set up her own studio business

When deciding on colours at Axminster she looked at tufts of fibres together, from above, because that would give you a better indication of colour than an individual fibre or viewing the fibre from the side.

She has two brands
Jacqueline Milton
https://www.jacquelinemilton.co.uk/
Offering classic nature inspired textiles printed digitally using pigment inks on a range of linens.

These fabrics are recommended for soft furnishings, primarily curtains, but not upholstery because they are pigment printed and therefore do not meet rub requirements.
This is Jacqueline's main range and is designed to suit country houses made of natural stone and fit in to a market where people like to use good quality fabrics which will last and not need to be updated (because the design / colour has gone out of fashion or because the fabric has become worn / faded). She is inspired by the environment around her in the Dorset countryside using for example, flowers, feathers and bees as motifs and keeps a calm, natural colour palette using greens, blues and creams in soft earth or pastel tones with some stronger highlight colours such as yellows, reds and pinks picking out details (wings on birds, bees bodies, flower stamens). These highlight colours are not highly saturated but are strong earth hues.

Kess InHouse – Jacqueline Milton
https://kessinhouse.com/pages/jacqueline-milton
Kess InHouse is a print on demand, homewares company that offers artist designed homeware products. As a designer you upload your designs and Kess InHouse shows them as product mock ups on their website, handling the production and sale, passing on a commission to the artist selected. Artists have control over what products are used with their design as they select the products when a design is uploaded.
The designs are busy, bright, bold and fun frequently incorporating a complicated repeat. Many are geometric but they are also nature inspired. As it is the design which is sold rather than a printed fabric the same rigorous testing and colour sampling has not been required such as that which Jacqueline has conducted for her main brand. As the sales are made by web the colours have to be strong and saturated to stand out.

Meeting with Jacqueline Milton
1st August

Colour Choices
Jaqueline has used a number of ways over her career to choose colours

- Looked at colour trends, such as mix magazine but found that the best way to forecast home and interior trends is to see what fashion colours are popular in the shops at the moment as the interiors market follows suit a few months behind
- Inspired by nature, particularly for the classic designs she produces
- Other people's taste, her colour choices for her brand can be governed by other people's taste as they have to fit her market, suit the homes of her clients and retain a fresh, classic look that doesn't become dated
- Patternbank Trend reports and courses
- Pantone colours, but mainly used for communication for example when selling her designs on paper she would attach pantone chips to them to communicate the print colours required to produce the design, or if communicating with printers to identify the colours she is expecting the print to be.
- Paint Charts, such as Farrow and Ball, using these to identify the complementary colours that might be used within the home on walls and furniture to match the soft furnishing fabrics Jacqueline is producing
- Designers Eye, tacit knowledge and experience of what works and sells

Jacqueline has conducted a number of tests and experiments to get to a product that she is happy with

Trialling printers
Testing out dyes / inks: pigment and reactive
Trialling out substrates: cottons, linens and some silks (primarily linen, cotton and silks have been experiments but she particularly was pleased with colour outcome on silk)

Additionally

- she has had fabrics tested through the Shirley institute for rub tests. She has also used her fabrics in her home and discovered that the reactive prints had poor lightfastness which is an issue with curtains which will be hung in direct light. The pigment prints had poor rub tests but good lightfastness which means she can recommend her fabrics for curtains but not for upholstery. She has also experienced prints bleeding when tested (rub and wash)
- Tested out sewing services where she has had her designs printed and made up into tea towels, oven gloves etc

She has had issues with colour consistency across designs where the same design has been sent for print samples and printed by the same printer using reactive dyes and pigment inks. The colours are very different with the pigment ink print being very pale and washed out, in comparison to the reactive dye print. The same file was sent to print again using a different print bureau using pigment inks and the resulting colour was again different, not so washed out as the first printer but the colours had a yellow tone to them. The design was then adjusted and printed with the second printer using pigment inks to get a result that Jacqueline was happy with.

Jacqueline has approached around 6 different print bureaus and found them generous with their time. However, she has experienced poor customer service from one digital print company and found communication difficult, especially over inconsistency issues. Eventually this made her feel apprehensive with the process despite Jacqueline having a strong industry background. Jacqueline found that print bureaus (like all businesses) vary and was keen to find a printer that she could build a relationship with.

Designs have come back with larger than expected margins meaning fabric was wasted, designs have come back at different scales and the substrate quality has been variable (slubs in the fabric, pulled threads).
She was relieved to hear that the researcher has heard similar stories from other designers.

Jacqueline found that most of the printers will offer their studio time and a colour matching services (for a fee), but no one has yet provided her with a colour profile or a recommended colour space to use.

To test out colours and overcome colour inconsistencies across substrates and dye / ink types Jacqueline created a colour sample sheet that adjusts hues using brightness and saturation in increments (from dark grey versions of a hue through to the most saturated, pure version). These are displayed in a grid formation with the values written in text on the x and y axis. The

increments were made using the HSB values in the colour picker and go up from 0 to 350 in the Hue circle.

The test sheets were printed using both reactive dyes and pigment inks. Jacqueline requested that they be printed on a creamy cotton but whilst the reactives were, the pigments were not, meaning that the substrate colour would cause an additional variable to the print. The test sheets demonstrated that there should not be such a huge disparity between the pigment and reactive prints.

She printed the test sheets again with a different print bureau on two different natural linens with a thick weave and texture, with good results. She uses these test sheets to adjust the colours in her designs when colour sampling (sending designs for print and comparing the results with what she is expecting / wants and then going back to the test sheets to identify the colour she wants, and then adjusting the levels in the design accordingly)

Jacqueline has also used a sewing service to have products printed and made up. They were printed with pigment inks. They promised 4/5 washability at 40° meaning that the fabrics would not fade quickly when washing. This was important as the products were tea towels and oven gloves so would get dirty quickly and need lots of washing. However when conducting her own tests on the samples provided she discovered that the pigment prints had really poor washability and faded after one wash. She therefore didn't go ahead with the order.

Jacqueline starts her designs by making written notes about design ideas and colours. These notes conjure up images in her head, which are then sketched out to establish the pattern repeat. These ideas are then translated onto larger scale paper, by hand using gouache / water colours. The designs are rarely more than 10 colours. She uses tracing paper to plot out the design so that it is in the correct position for the repeat. These images are then scanned in and cleaned up in Adobe Photoshop. This is a time consuming process but vital. She uses a tablet and stylus when using design software. When a design is scanned the number of colours in the design increase because the digital image is made of pixels so Jacqueline reduces the CAD file to a manageable number of colours. As well as Photoshop Jacqueline uses Illustrator.

Jacqueline likes Designers Guild and Sandersons digital prints. She finds inspiration from Collier Campbell, world textiles, William Morris and Tricia Guild. She could tell the difference between a digital print because of the number of colours it might include but has been surprised that some of the high end design companies have switched designs to digital print because their usp has been producing large colour designs by rotary print (you pay more for more colours in this type of printing)

Jacqueline is aware that digital print is not a perfect means of printing textiles but likes how it has opened doors for her to set up her own business and have more control over production. She does not have to carry large stocks of fabric and can react to design ideas and trends quickly. She uses pigment inks for printing because they are reliable and consistent.

She would like to see improvements to pigments where they become embedded into the substrate so have better colour quality, washability and rub factor.

Made in Brighton- Design Studio

Interviewee: Liz Moss from Made in Brighton
Interviewer: Becky Gooby
Date of Interview: 22nd January 2016, 26th July 2017 and Questionnaire 5th October 2017
Method of Interview: In person at Made in Brighton Studios (Paintworks and Knowle) plus Questionnaire
Consent given: Yes
Write up approved: Yes
Recording : No recording, write up made from notes at meetings and questionnaire

Duration two mornings and questionnaire

Summary
Made in Brighton said that DTP had revolutionised their working practice. Having their own inhouse printer meant that they could print samples and strike offs quickly and have them ready for meetings with clients, responding to new trends and looks. They had done a lot of experimentation with altering washing and steaming times to get colours and fixation right. They had experimented with working in RGB and CMYK colour modes to get colours accurate. They used [Redacted DPB B]'s RIP and artwork was loaded directly into the printer using a USB so there wasn't much information about the RIP on a separate monitor to view. They had issues with particular colours; pink, black, red and pastel shades. They were having to learn on the job and mistakes such as not noting which ink cartridges had gone into which print head after a move which caused colour issues. They had a bullet steamer which wasn't very powerful but as they were primarily using the printer to print samples they had simply adjusted the steaming times to get better colour results. The changing and evolving textile market was having a big impact on their business model. Digital print had enabled them to become more entrepreneurial but was challenging because they didn't have the experience or skillset so were learning as they went.

Postscript
After these interviews were conducted, Liz very sadly died. Her partner Lydia continues the business but has recently put their printer up for sale because she does not have the space or inclination to continue operating it.

About
Made in Brighton are a long-established and innovative print design studio. They have evolved over the years from a large design studio employing several designers and freelancers to a more simple business in response to changes to the market. They bought their own digital textile printer, a Mimaki TX200, to print strike offs and samples and to experiment with printing their own products. They have had to scale this back as the business has changed. The interviews were conducted with Liz Moss who was codirector. Sadly Liz died in 2020 but her business partner Lydia was keen for their contribution to remain part of the research project.
https://madeinbrighton.co.uk/home.php
https://www.instagram.com/madeinbrightonstudio/?hl=en

Notes from meeting with Made in Brighton
22nd Januaryb2016

Made in Brighton textile agency
Working in Paintworks
Have a team of freelancers and employees

Using different fabrics
Bamboo the black doesn't dry and transferiing on to the back of the fabric smudging it

Had been taught that for paper printing that CMYK was a better match but printing in RGB

The drying times for silk habotai and silk twill seem to be very high

Changing inks half way through cases colour cnahges
Washing processes have been experimenting with 40 degrees for 40 minutes

Use R A Smart
When printing cotton twill it broke the machines

Printing RGB for heavy weight silks and habotia only

Issues with warm reds and any blue that not able to replicate work
Colours like neon green
Pinks purples pale colours
Change particularly when new inks inserted

Issues with coated fabrics or the way the fabric goes through the machine such as slippage and bleeding from the blacks

Also getting an electric charge off the fabric

If they print CMYK the colours seem to come out ok
They calibrate the machines for large runs of heavy weight fabrics but it seems to have made the colours bleed more

[Redacted DPB B] have recommended that they wash and steam on a hot day

They use a washing machine and iron it quickly which seems to stop the bleeding

Made in Brighton
Meeting 2
26th July 2017

Moved studios from Paintworks to Knowle
Paintworks was £20k per year this studio is £500 pm

Industry rapid decline
Hedgefund firms taking over fashion houses and stripping the assets and then letting the business go down the drain

Therefore their market has reduced for selling textile designs as an agency
They have reduced the number of employees and no longer use freelancers
Selling designs on behalf of freelancers has become too costly and if you sell too many of their designs in one day it actually costs the company money

MIB are therefore sticking to selling to their client base who are local to Bristol

Substrates using

Belgian linen
Stretch Cotton
Half Panama
Silk

The studio has a Mimaki TX2-1600 which uses an ink bank of CMYK orange, red and blue
It uses SmartPrint as the RIP and has three profiles, cotton (light), cotton (heavy) and silk. They take a usb stick from their computer and plug that directly into the printer to print their files. The printer is supplied by [Redacted DPB B] as are their fabrics. [Redacted DPB B] have been rather unhelpful when it has come to technical issues and have generally implied that this is what digital print is like

When they moved studios recently the inks were removed from the printer but the order was not noted and when they tried to set it up again the printer wouldn't work until the correct ink chips (each cartridge has a computer chip) were in the right places.

They have a bullet steamer which technicians have noted is not good enough for steaming fabrics to fix them so they have had issues with fixing the colour. However a new steamer would be costly (£4.5k) so they will continue with this set up for now. They have several washing machines which they use for washing the fabrics

MIB have two modes of operation

- Textile agency supplying designs to fashion industry (main function)
- A Not on the High Street brand 'Little Paradise' where they sell cushions and garments that they have printed and made up (side line)

Liz has been conducting a number of experiments

- Experimenting with steaming times, for example she has discovered that 3 hours of steaming fixes the half panama much better than 1 hour, but silk fixes after just a 30 minute steam

- Washing experiments, Liz mentions that Whiston and Wright (another agency) http://whistonandwright.com have just put thicker fabrics in buckets of water. They have printed thicker fabrics which have got white lines on them when they've been washed because the fabric has been scrunched in the washing machine and the dye has been removed (possibly an issue with steaming not properly fixing?) Liz therefore washes these fabrics in the bath and hangs them to drip dry

MIB have had issues with printing

- Stretchy fabrics have not printed well (perhaps because the stretchy fabric has not liked going through the Mimaki and Mimaki actually say do not use stretchy fabrics on this printer)
- Bamboo fabrics ink not drying
- Colours changing when inks have been run out and new inks put in
- Pinks are an issue, if Liz increases the ink levels from 80-90% then this helps achieve a better colour but they struggle to get pastel colours (probably because they need LM and LC in the ink bank?)
- Blacks bleed, so she has kept ink levels at 80% for blacks
- Blacks looking purple rather than black
- When printing black text onto white background image quality has been poor

Becky suggested

- Asking [Redacted DPB B] to send her the profiles so they can upload them into Photoshop to see what happens to the colours
- Putting black compensation on the print (increases the amount of black pixels) particularly when printing text but also making sure the black is 100% in the CMYK colour picker and all the others are 0%?
- They discussed coatings and also using a different fabric supplier, Becky suggested Premier or Whaleys or making their own
- They discussed other printer types
- They discussed sRGB and Adobe1998 profile which we use at UWE

Questionnaire 5th October 2017

1. How would you describe your approach to colour? Do you have an instinctive colour style?
   As a studio our approach to colour is largely dictated by the latest catwalk trends and client needs. We have a bold style and tend to use strong colour palettes. Our target market is the 'missy' market (over 40's) and the 'curve' market where strong, bold colours are preferred because they are more flattering.
2. What designers inspire you? Who do you think uses colour well / uniquely?
   We are always inspired by Etro, DVF, Dries Van Noten and Marni. Their use of pattern combined with off beat colour palettes is always a great source of inspiration for us as designers.
3. Do you have a systematic method for selecting colours in your design practice (for example planning out a colour palette using a colour system such as Pantone) or would you say your colour choices rely upon 'designer's eye'?

Sometimes if we want specific colours – colours that are seasonally important - we will test them in advance. Most of the time our colour choices are based on our designers eye. This is due to time constraints as we are usually working to a tight deadline – we turn around a new collection ever 4 weeks.

4. Do you change your colour choices depending on the substrate or technique you will be using?

   We print our entire collection on silk Haboti , we only adjust the settings on the printer when we are printing pale pinks. 90% as apposed to our standard 80%.

5 Do you use Computer Aided Design (CAD) in your design practice? If so what software do you tend to use (for example, Adobe Photoshop, Adobe Illustrator, CoralDraw, AVA)

   We use, illustrator and photoshop.

5. Can you describe your design process (for example, what mediums you might use, whether you begin using hand techniques and incorporate that into a digital file, what methods might you use, are there particular sources of inspiration that you begin with)?

   Many of our designs are hand drawn and then manipulated in the computer. Typically we would find inspiration from a book or catwalk images and then use water colours, ink, or gouache to create a design.

6. What sources do you use as colour inspiration? (for example colour forecasting and trends, photographing colours you like, colour systems such as Pantone, objects around you, mood boards, collecting items with colours that you like)

   WGSN is our go to source for colour inspiration, many of our clients use this trend service and so we know we will be on the same page as them.

7. Would you describe colour as critical to your design practice?

   Absolutely! Sometimes we sell a design because of the colour and not the pattern. Colour is everything.

8. Can you tell the difference between a digitally printed fabric and a mechanically rollered or silk screened one? What do you think of digital printed textiles?

   Yes you can tell the difference, especially on heavier fabrics. We use silk Haboti which is very forgiving. We are still to conquer the perfect black and red!

9. What role do you think digital inkjet textile printing has in the textiles market? (for example is it purely for sampling, one offs, more avant-garde designs, printing photographic imagery, an empowering tool for entrepreneurial designers)

   As a small business digital printing has totally revolutionised the way we do business, we can do small runs of meterage for clients and respond to catwalk trends very quickly. In the long term I hope it brings more production within the UK, although the price per metre is still comparatively high.

10. Are you aware of colour issues in digital inkjet textile printing? Have you encountered colour issues and if so what measures (if you're happy to share them) did you take to overcome these? (for example consistency issues, translation from design into print and so forth, issues that students you have worked with may have had) ?

    Yes!! Red, black – pastel shades. Sometimes the results are disappointing – we take what we learn from each print and adjust accordingly for our next collection. As there is no time for re prints.

Melissa Ougham- Textile Design Graduate

Interviewee: Melissa Ougham
Interviewer: Becky Gooby
Date of Interview: 4th March 2017
Method of Interview: Audio Call
Consent given: Yes
Transcript approved: Yes
Recording: Melissa Ougham.WMA

Duration 45 minutes

Summary
When we had our conversation, Ougham talked about lacking trust in digital print and that her expectations were low in comparison to hand print techniques. She choses to print on linen because she feels the texture disguises colour and quality issues. [7.44] [13.50][23.57]

At University, Ougham was given a strong grounding in digital textile printing with dedicated workshops run by the print technicians. The workshops encouraged students to run colour sample tests before printing and provided them with a colour sheet of achievable colours. Whilst students were not allowed to operate the digital textile printer themselves, they were expected to carry out the secondary processes of steaming and washing so that they could understand the dyes used and the colour implications. [19.46] [22.02]

When Ougham has worked in industry she has created designs to specific colour palettes but as a designer has not been part of the manufacturing stage and had to engage with printed product to assess colour results. [1.59] She has a Pantone set but doesn't reference them. Her own colour management process involves creating a colour palette using painted samples and matching them to her digital palette, continuously referencing this palette through the design process. [26.42] She'd been taught to print her colour palette across substrates (for instance linen, cotton and silk) because 'different fabrics react in different ways to reactive dyes'. When presenting hand printed and digitally printed fabrics in the same collection, Ougham would have to make adjustments to the colours in her hand prints to match the digital because it was harder to make accurate colour adjustments to the digital prints. This would mean brightening the hand print colours to match the saturation of the digital prints. [30.39]

Ougham understood the importance of retaining the correct colour settings in the CAD file and refraining from adjusting the levels once colour tests had been performed to prevent colour discrepancies. She finds she uses a lot of neon and bright colours when digitally printing because that is the aesthetic she is drawn to on the screen. Ougham has set up her a shop online to sell her designs and continues to work freelance whilst employed as a technician at a screen printing studio. [38.26]

About
Melissa Ougham
New Textile Design Graduate
Selected for TexPrint 2016 - http://www.texprint.org.uk/index.php/year/2016
Awarded internship at textile printers in Lake Como, Italy
http://www.melissaoughamdesign.com/

Melissa Ougham is a printed textile designer. Her colour palette features earth colours and her primary medium is screen print although she does use digital print as well. Since graduating she has built up her digital print portfolio because her industry experience has been in digital print and due to lack of access to screen print facilities. Her design process frequently starts with drawing and hand techniques which she will scan in and manipulate digitally. She finds digital design restricts the scale that she uses and that she often loses the sense of size and colour and that both these elements might evolve drastically from the original hand elements, when working digitally. She uses both Illustrator (drawing) and Photoshop (layout) as her design software. [11.37]

Transcription of Interview with Melissa Ougham
4th March 2017

General conversation between Becky and Melissa including permission to record the conversation

Becky: Ok great well thank you so much for speaking to me and we didn't actually get to meet at TexPrint I don't think because you'd disappeared off somewhere and somebody else said oh yes she'd love to speak to you
Melissa: Ah yes well I was probably having lunch somewhere
Becky: Did you enjoy it, as an experience? Or was it quite stressful
Melissa: Yes definitely it was I'm still been sort of I've just got back from Italy so that was something that came out of TexPrint so its all been a bit crazy so its been really good but its been great I've met a lot of people so I've thoroughly enjoyed it yeah
Becky: and Italy was that doing an internship?
Melissa: Yes I was doing an internship in Como and I was working, I worked out there for two months in a print and weave mill. So I was doing design, mostly CAD work for them and most of it was actually for, I'm a printer so I usually design for print but it was for jacquard and some embroidery so that was quite fun
Becky: Did that challenge your way of working did you have to adjust it because it was for weave rather than for print?
Melissa: Not so much because of the outcome, there were certain things so learning about the machines for the embroidery you could only run one colour a certain way so that changed your design slightly but it was quite the same concept because it was for jacquard it was the machine can almost do anything.
Becky: They're pretty magic those aren't they
Melissa: Jacquard machines are something I didn't know about before but they've blown my mind.

Becky: And now you're back at Sanderson you said that's the third time you've been there? [1.59]
Melissa: Mmh yes so well it's the third bit of work I've done with them I've sort of just been doing freelance projects for them so I mean the first time I was a bit more a design assistant in the roles and things I was doing so I was working with mood boards but for a sketch book it for a client, to bring to client meetings to show how they brought their collection it was for the art of garden one, so I was working on that the first time. And then the second time I was doing a bit of freelance damask work so I was doing some treatments for their new damask line but I'm not sure, they're unsure where that collection is going in terms of the output. And then this time I was helping one of their main designers on a paint project so they want to, they want to re-do their whole, you know they do their paint collection they want to re-do it. And I think the last time they did the colours was in the 60s so they were looking to sort of revamp it and have a look at the colours and I was looking at matching colours with their best sellers and going from there to see whether there are gaps and what they can lose and what they don't have to lose so I've been doing that but I finish that work just because they've got a few meetings coming up so they need to see where there meetings take them obviously so we've done a bit of the research and creative side in terms of sourcing colours and finding new flat colours that are also on trend and also fit with their best sellers and things like that but they need to see from the big bosses whether it's a go or not so I'm currently on hold
Becky: It's a real range of skills that you're being required to have at the moment then
Melissa: Yes I suppose I've kind of yeah. I would agree, its kind of been a little bit of everything to just sort of organising in some places to do full collections and designs so I had a lot of design freedom at Tiana which was the place in Como. I was doing very quick fast paced work for them so that was more of the fashion world, where as I'd love to be more in the interiors world but in this economic climate I'm not picky but I think that I've kind of depending on who I've been with the role has changed drastically and its kind of been more a fact of what they need doing where they've got the holes where they've got the gaps in their studios in to what they need me for, because most of the things I've been doing has all been freelance so its kind of been as and when and what they need really
Becky: Well that's great that you've got that versatility, as you say that means you can plug in to what they need and that gest you the work and the experience and the build up of experience is really important
Melissa: Absolutely definitely
Becky: So with your prints the ones that I saw at TexPrint they were kind of a mixture of handprint but you do do digital print as well.
Melissa: Yes that is correct, in my collection that you saw I probably had more hand technique stuff but since I've graduate I've built on my digital portfolio purely for convenience in terms of I don't have access to a print room easily any more, and also my work at Tiana was completely all digital. So I was working completely with a graphics tablet which I am now quite comfortable using so that has sort of let me be able to design more digitally so I do use a range of both. My preference was hand but I'm quite enjoying what you can get with digital now sort of something I didn't really explore before.
Becky: Do you find that you're the way you work changes if you know that its going to be digitally printed? Knowing that you don't have to have separate screens say for the colours or do you still have a colour palette
Melissa: I think so because I the way I was sort of taught and the way that I was trained even with the layers I think of them as separate screens I don't know whether that's how I would naturally go about it but I think that when I'm I think that at first I would almost find it harder to

digitally design because of that reason so I would be like well if I was doing, the way I approach it because I was often designing by hand it almost limited me to what I would do digitally whereas I think now especially with using Illustrator I am being a bit more adventurous I think that now I'm sort of exploring the digital side more and more I've almost become freer with how I work does that make sense?
Becky: You feel less restricted? More confident with it
[7.44]
Melissa: Not that I find, I find the working by hand completely unrestrictive in terms of my hand movement, that's the only thing I do find limiting with digital is that I can't purely I can't paint as big as I usually would paint, I have to think about my scale in terms of scanning it in or taking a photo or something like that I have to be careful that I'm not drawing too big so that I find restrictive
Becky: So you're often starting off by hand and then scanning it in or photographing and working from the photo as your digital design
Melissa: Yes that's how I prefer to work when I do my own projects. With Tiana I was drawing completely solely from scratch on digital because that's how they wanted it done but I'm the project I do for myself or with freelance I usually tend to draw, scan or take photographs like you said and then edit them and sort of play around with my colour, because also the colour gets distorted as soon as you, yeah bring it into your digital file so that's definitely something you've got to remember and like get the, also scale, but sometimes its hard to get a sense of the scale you can be so invested in working on the file that you forget, oh actually this is 20 by 30 and I wanted it 40 by 70 because its virtual
Becky: You don't have that sense of same because its with hand you can plot it out a lot better but your kind of confined to your 13 inch or 15-inch screen of your laptop aren't you
Melissa: Exactly I think basically that's it isn't it because its on a virtual screen, for many of these designs they take, you could be working on them for up to a day just looking at the same section or something like that so you almost, sometimes you can lose sense of the size or the real colour that you put in. And I've worked on a few designs and I look at the outcome and I look at what I've started with and actually the colour has drastically changed or my scale has drastically changed, not necessarily for the worse but its evolved, its changing. But you do get that with hand done as well so in terms of you'll start off with original colour and by the time you mix all your dyes and the ways they react with the fabric, it's the same kind of thing but just with different ways.
Becky: It's a different planning process. And are you working mainly in Illustrator or do you use Photoshop or CorelDraw or anything
Melissa: I use Photoshop the most and then I follow, I use Illustrator if I wanted to, if I was drawing something completely digitalised I would use Illustrator because it uses vectors instead so the pixelisation is much better. But I would use Photoshop, I often draw in Illustrator and bring it in Photoshop to do my lay out, I find, I don't have access to anything like AVA which is the repeat program so I use Photoshop to do my layout and put stuff into repeat I just find it easier doing it by hand in programs such as Photoshop, rather than bringing in my blocks and setting it out, putting it into repeat. I use those two the most.
[11.37]
Becky: And when you've been building up your digital portfolio have you had anything printed or are you just getting the files together?
Melissa: A mix of both so I've had some work recently printed it would help if I remembered the name. Ill send it over. I have recently had a few fabrics printed just because I wanted it for my portfolio at interview and stuff like that so I can reference what I've done

Becky: Were they UK printers?
Melissa: Yes I can definitely get you the name of them. What I could do is I'll make a note and send over the name
Becky: Were you happy with the results or were you a bit like ooh that wasn't what I was expecting or
Melissa: I think that for me almost every digital printing I'm always have my expectations extremely low purely because from past experience with my Mimaki machine at uni. I think because I'm more naturally hand, because I use hand techniques, I'm sort of I never really wanted to trust it, so whenever I send something off I always think this will probably be rubbish so when I get it back I'm like oh I'm pleasantly surprised so I was I remember they were good again it depends on what fabric you find you print on so trial and error is a big thing of mine but I think that almost in a way to hide sometimes that the colour or the sharpness isn't quite right get a more textured fabric it kind of hides the mistakes of the printer more so that's something I've learnt so I always go for like a linen if I ever want anything printed
Becky: Linen always feels because its like quite a nice weight fabric it always feels a bit more professional sometimes than using cotton satin
[13.50]
Melissa: I know I wouldn't choose anything I don't really like shiny fabric anyway in terms of personal preference so I'd always steer clear of that and the silks that I do have are all ones that I've hand done. Actually I tell a lie I do have a few digitally printed silks but they were printed at my university on a Mimaki machine so I had almost more control in terms of I could run tests in a day and I could steam them myself and I could
Becky: where did you study Melissa?
Melissa: Winchester School of Art
Becky: Ok and are they quite focused on digital design there did you find you got quite a good experience with teaching talking about colour? I mean it sounds like you were allowed to operate the machine and getting it printed which I know at some universities they don't allow
Melissa: Yeah so in terms of the digital printing we the course was sort of set up, we weren't allowed to operate the machine as such but we had a technician and we would have workshops in the Mimaki, I think we had about two or three, she would teach us ok this is they would give you all the colours the machine could make and they would often, they told you to match your colouring to that, not many people did, but they would teach you that this was a way of matching your colour better so that you could understand how the machine would output, a lot of people would kind of wing it do a test run if it came out alright good as gold people would crack on with that but they did have sort of workshops in place where you could make sure that if you wanted that specific yellow you would get that yellow and they were quite good in terms of if colour wasn't right and it wasn't your fault, it wasn't the file they would reprint it, and also as soon as the fabric went through the printer it would come to us and we would steam it ourselves so in terms of that we had control over our fabric.
Becky: So you also got to see the colour difference between when it came off the printer to what happened when it steamed?
Melissa: Yeah because we would pick it up after it had been air dried and made sure it was dry and before you put it in the steamer you would think oh my god this is so dark depending on what fabric it was on and then it comes out the steamer and it has completely changed so in terms of that I understand how the dye works with the fabric and with the coated fabric before it goes through the printer. But our course was also they didn't steer you in either which way so they taught us everything that they knew about the Mimaki and then they taught us everything to do with the hand printing because we had big printing tables in our studio so we were quite

lucky we had the space and we had the machinery to expose our own screens and do registered lengths along the tables. My course was completely split I would say I would say about 12 or 13 of us would all hand print with digital because you had to have they wanted to see a range they didn't want to just create students who could only do one or the other. There were a few people. And the other half were much more digitally dominated and would only be in the print rooms for a handful of their designs so it was quite even actually

Becky: That's really interesting because I've spoken to, loads of people have been hand printing perhaps because of the cost but also because they enjoy the process its nice to be as you say be in control and its nice to be very involved in creating those colours yourself but there seems to be a distinct lack of the kind of workshops that you're describing quite a lot of universities don't seem to offer those so that's really great that Winchester did that because it kind of gives you a bit more knowledge and then a taster of what digital print is about so that's really great to hear

Melissa: Yeah it was definitely in terms of they were encouraging to do both and I think because our course, I have spoken to quite a few people, they were charged to coat their screens in terms of the hand techniques so that forced them to do digital. We didn't have that we weren't charged for our coatings so I was quite able to afford to hand print whereas I think it was at Nottingham and maybe Leeds where it was about £15 for a screen and when I think about my final collection in terms of. I mean I had some prints that were 8 screens so I had 80 designs in my final collection so if you add that up there was no way you'd be able to afford that.

Becky: Gosh I hadn't heard of that unis charging for hand print at all wow that's a real change I know most charge for digital

Melissa: Yeah so it pushed them into digital so it was kind of like the other side of the spectrum. As often you hear of oh digital is too expensive kind of thing.

Becky: That's really shocking.

[19.46]

Would you, I mean if looking around at other designs and stuff, are you able to say, on the catwalk or in that particular shop, that's a digital design or I know that would be rotary printed or screen printed, do you feel that you'd recognise the different aesthetics or

Melissa: Yes I think that I would sometimes I get tricked and sometimes I have to go up and really feel it or look at the back of the fabric but yeah I'm definitely I would hate to say a print snob but every print I see I try and guess what its printed in I think it comes with the nature of it doesn't it in you when it becomes your whole world you look at something and go yep that's pigment or that's procion, that's definitely digital and I think that it's a shame sometime because I think that if people could really understand, I don't know maybe it's the knowledge behind the process but I think once you know how digital and both hand work there's no need for it to be noticeable if that makes sense if you use your layers and your software properly you can create a digital print that looks like it has been hand silk screened you know but I think that maybe its to do with the fast fashion element but the machine churning, it creates prints that are a bit obvious.

Becky: They're a bit flat or that mirror design that people do that really annoys me now

Melissa: My tutor actually banned us, she was like I don't want to see a mirror in people's portfolio ever.

Becky: Its very easy to get sucked into I have to say I have got some mirror prints in my portfolio but now you sort of see Ted Baker and everything is a mirror design down a dress, its lazy.

Melissa: Yeah that's it, and there's ways of doing it really really sophisticated and then you see some and you think would it have taken the designer 13 more seconds just to put something else in it.

[22.02]

But like you said its all just dead lines and all of that
Becky: Costs yeah, economies of scale all the boring things
Melissa: Exactly all the things that creative don't want to hear
Becky: So I've been doing some experiments recently where I've been putting things through the digital printer more than once so like with silk screen printing one colour at a time so you get these beautiful fugitive colours where a blue crosses over a yellow and all of a sudden you get a green and that's quite exciting because that begins to improve some of the depth that silk screen printing does a little bit
Melissa: Yeah that overlapping yeah definitely
Becky: So that's quite nice and that's some of the things where you realise the fact that all the colour is printed at once and you get no overlapping and no, kind of, some of the colour mistakes that you get with the silk screen printing so that's been quite nice to experiment with
Melissa: And that's almost I think that's what I miss I think that's originally, that's what I love about fabric when you find the mistakes when you see what someone's accidently put their squeegee down in the wrong place, it adds character
Becky: I love it when you get a thread that's stuck under the screen sometimes and you get a snail trail
Melissa: But I think actually that's really interesting because I think some of the designs that I would design in Photoshop you would almost because you think because it all gets printed at the same time you almost avoid overlapping whereas when I hand design that's how I get my third colour in order to avoid the third screen I have to make because who wants to make an extra screen for themselves no one so you try and utilise what you've got so that's really interesting
[23.57]
Becky: And the other thing I've been experimenting with is Pantone colours just to see how they print because at UWE where I am that's the colour management the colour system that the students are recommended to use so they say always use your pantone colours they're the ones you'll use for your swatches so it doesn't matter if its digital print or hand print go with Pantone and about 1/5 of pantone colours are not possible to print through CMYK printer because they can't be made up from Cyan Magenta and Yellow so I'm, yeah I was a bit shocked, but its been interesting to see, mainly purple it seems, but I'm going to try and do some experiments with those but is Pantone something that you tend to use or do you come up with your own colour system your own colour swatches?
Melissa: I do have Pantone colours however I don't actually think I've ever referenced them really. I yeah no I wouldn't' say I do I do it often all by eye or if I'm working to a specific brief I would usually have a colour palette but then again I'm thinking of the roles I've done in industry where the printing is sort of taken out of my hand I'm purely just the design and it sort of filters back very slowly but in terms of my own work I don't think I've ever referenced Pantone once no.
Becky: Yeah Ok and do you do with your digital print do you embed a colour profile before you send it off or do you just accept what Photoshop has chosen, colour profiling tends to be something that's done in the graphics industry but so far in textiles it doesn't seem to be so common
Melissa: No I wouldn't necessarily leave it all to Photoshop so in terms of, I would usually do I would print, get my colour palette, so have my colour palette painted and in digital and then match them as closely as I could and then I would put them into a file and have that digitally printed on the Mimaki and then once they came out I'd match them against my flat colour or my dye colour so that's how I would tackle trying to get the accurate colours and then once

you've got those colours in your Photoshop file I would just constantly reference them. So if I knew I wanted a blue or wanted tone of that blue I would just go up and down on that colour spectrum and that is usually how I'd go about that.
[26.42]
Becky: That sounds like a really organised way of doing it and actually from the other people I've spoken to lots of people are saying I do it by eye and I rely on my designers know how to work out what my colours but I have this thing that I'm constantly I know this is the colour that I want so I'm constantly referring back to a colour palette or I just know exactly what I want
Melissa: Yeah and also I would we were encouraged to always print one on linen one on silk and one on cotton because different fabrics react in different ways to reactive dyes that are the same so sometimes in collections you were really lucky and they all came out exactly the same other collections you aren't so lucky and your silk was 7000 times brighter than whatever fabric you were printing on so that was sometimes tricky in terms of, and that would cause big problems when I would print my digital stuff side and then I had my hand done side of the collection and they'd look completely different. And they'd look like they were in separate collections so I had to try and, because that digital was so I mean I remember one print I reprinted it probably 8 times in different colours on different fabrics you'd change the colours on the file but it wasn't doing anything it was just coming out really bright so I had to try and bring that brightness into my hand and try and add really bright acid colours to try and link my collections
Becky: So you had to adjust the hand print rather than the digital
Melissa: Well my digital was too bright but because of how many times I'd tested it and at that time I had deadlines but I had to create new prints in my hand that were really bright so that the digital would fit in. So it was a little bit more cohesive so I have had problems but the idea is a good idea and sometimes its fine but sometimes it just wasn't working out
Becky: And I've spoken to people and they've printed on one machine and then the machine has run out of ink so they've moved to the next door machine and its exactly the same Mimaki and its exactly the same fabric and its exactly the same file and then the colours have come out completely differently so they haven't had colour consistency either
Melissa: And another thing is that on digital its really really easy in terms of just moving your saturation up and down and turning your brightness up and down, you forget how much of a difference in terms of your out product so by the time you've had that printed because alright lets say I've used all my colour palette colours that I've referenced and I know they are the exact colours but if I change any of those ever so slightly I'm producing another colour palette which I haven't tested and I haven't run so I think its so easy to create because digital is so easy to create this, and you've got 1000 colours at your finger tips its easier to produce more discrepancies than it is by hand because for hand dyeing you've got to physically make another hand dye so I think its harder and you're always using the same pots of dye so it helps to keep it cohesive whereas in digital I often find sometimes I get really really carried away with my colour and I look at my collection at the end and I think oh my god this is supposed to be tonal and natural and I've got neons because even if that's, that might be what I'm naturally drawn to personally so its so easy to bring it all up and once you've brought one up you want to bring the others up
Becky: And it looks great on the screen because the screen is backlit
Melissa: Yeah exactly
[30.39]
and I think I fall into that trap very easily
Becky: That makes a lot of sense to me I understand that

Melissa: Yeah its just so easy to do especially when you're like now let's try it like this, because its almost like your experimentation that you can do changes really really quickly and you get carried away
Becky: Yes I totally agree. What's next for you, are you thinking of trying to set up your own business or are you going to keep doing freelance work what are your plans?
Melissa: Right now I am doing a bit of freelance work but my main goal is to find something more regular so I'm applying for jobs and I'm doing I'm sort of trying to network here and there but also I'm working on my portfolio so filling gaps that I feel I have and also I mean I almost want to do all of it at once I also want to set up start putting my stuff into some products as I'd really love to have like these I'd really like to start designing really nice bespoke cushions and wall coverings and stuff like that but I need to sort of focus on one thing at the minute. And also financially its not all viable especially not in my position I need something I either need to commit to making my end product and my and just concentrate on that and do freelance work here and there to get money in or I need to concentrate on getting something more regular and then put my energy into that so I'm a little bit torn at the minute I would have to say
Becky: Its quite scary isn't it that first step
Melissa: Yeah it is a little bit and I'm almost in the limbo because I'm in between so I'm like I'm in between sort of I've got a bit of freelance work here and I'm doing a collaboration there so I'm sort of concentrating on that but then I'm also with the freelance you find yourself with some spare time thinking oh this could be a good opportunity to start building ideas for my products and starting getting maybe building getting a small collection together and then you have to drop that and concentrate on something else and then you're like well maybe I should get a job and its just argh! So I'm a bit everywhere at the minute but I'm trying to concentrate on what I'm working on right now and once I do that I can work on something else and take it day by day and step by step
Becky: I think that's very wise somebody once always said to me as a freelancer if you look back at what you've done that's less terrifying, because if you look forward it can be an endless stretch of nothing but if you look back you can go oh yeah I did that and I did that and I did that
Melissa: Yeah and I've done this and I've just been here and I'm doing this now, yeah I think its hard isn't it because you just go oh my god what am I doing tomorrow. I look at my diary and think next week is empty I need to fill it but by the time you know it by the time I get to the end of this week something will pop up because that's kind of how its been happening you don't' know what you're doing in a fortnight but something has popped up for next Tuesday. So you do that and by the time at the end of the week you've got something else so you know
Becky: Or you over book yourself and then you feel like a right wally
Melissa: Yeah I've said yes to four people I can't be four different places at one time! But no one day at a time like you said but yeah its been challenging to say the least its. Well they always tell you its going to be hard but you never quite expect it when its happened
Becky: And how did you find premiere vision, because I spoke to Emma Kendall and she was saying that it was quite grim it was quite, she said it was, you were in a funny corner at the back and no body was really walking past?
Melissa: Yeah but I found Paris really difficult in terms of mentally but having said that I have met in hindsight to Paris, at the time I was like oh my god I'm not interacting with anyone but once I got back. I've had two freelance jobs from it, paid freelance jobs so I can't really complain and I've met people so it sparks things I can't lie and say that it didn't
Becky: But you must have been pretty tired from graduating, Texprint, premiere vision, that's all kind of all in one go isn't it.
[35.24]

Melissa: Yeah definitely since I graduated its been crazy I've had intern placements in the summer than I was at Zoffany I was also doing my collection at Winchester and then I did Paris and then I got back and did a Freelance job and then again and then I was in Italy and it just kept going and going and going so I think I also whenever I was at for example when I was in Paris I was still trying to catch up with myself and also it comes so quickly and especially times like now when its almost coming in more steady I'm like there's nothing when in actual fact there is stuff and I am busy and I am doing things but because it wasn't at that pace that I almost got used to for the past 6 months, it feels slower, but Premier vision it was good it was an experience I learnt a lot in terms of my how I need to interact with the market and my work because my work is quite freehand its not entirely commercial and I have to sort of tap into the fact that I suppose you would say its more of an artistic thing instead of a reality so in terms of filing my portfolio now I'm trying to fill it with more of the commercial side so that I can just show that I am a versatile designer and I can bring different things to the table but my natural freehand and my hand writing myself is very fluid and very abstract so I think in terms of premiere vision I did learn a lot but it was tough but the thing that made it so great as well was that I didn't feel alone so I think if I was doing that on my own for the first time it would have possibly knocked me back in terms of I wouldn't had the confidence to get up and keep going. Whereas I think that's the great thing about TexPrint you're doing it all together you all don't really know what to expect you've sort of you've all been thrown into it a month earlier so I think that was good I think if it happened any other way it could have been a different outcome
Becky: A good peer support
Melissa: Definitely because I had some people who were doing really great but they were really encouraging, I had other people who were in the same boat as me, in very way you didn't feel like you were on your own. Basically there was always someone on another stand that had the same feeling as you or if they didn't they weren't, I had a good bunch in terms of no one was you didn't' think oh go away everyone was really encouraging and everyone was quite motivating.
Becky: That's good to hear.
Melissa: Yeah it was good
[38.26]
Becky: I think you're doing all the right things you sound super organised and setting up your portfolio to show that's its versatile and that you've got a range of skills it sounds like you're incredibly knowledgeable anyhow so I'm sure you will do very well I think that, I mean I liked your style
Melissa: Thank you its always nice to hear
Becky: Well I will let you go but thank you so much for speaking to me and what I'll do I'll transcribe the recording and send you a copy so you can check that its an accurate recording of our conversation and then what I'm hoping to do, because I need to evidence how other designers are working but also to evidence that there are colour issues so what I'm going to be doing is taking parts of the conversations I'm having with people and I'm using them as part of my evidence and I'd be very happy to anonymise you if you'd prefer it to not be in your name and I'd be very happy to send you some of the work that I'm doing so you can see what I'm up to so you can check that I'm not misrepresenting you in anyway and again if you've got any questions or queries for me if you suddenly think ooh I don't know what she meant by that or I'd love to know more about that, the double pass printing or anything please feel free to give me a shout but I'll basically just keep in touch with you through out the PhD because I'm hoping to come up with some methods myself for people to try out so if you have time to give them a go to let me know what you think of them like I'm looking at pantone because most people have

said that they use pantone but if that's not what you'd use then it maybe that some of the methods that I come up with are not appropriate and you might say well actually that's not I don't find that very user friendly because I don't use pantone so that's all good feedback to have as well
Melissa: Ok Cool, no it sounds really exciting it sounds really interesting
Becky: I'm really enjoying it
Melissa: It sounds really fun actually and also in terms of what you're saying and finding stuff out I'm absolutely down for that because like you said having that mentality when you think about your digital file in a different way you sort of compartmentalise how you approach something. So banishing it, getting rid of that could be really helpful and I could get some really exciting stuff so I'm happy to stay in touch and carry on
Becky: Thank you, I think I've probably been one of those people who has winged it a bit with digital print so its really nice to hear that other people have planned properly and how that works
Melissa: I wouldn't big myself up too much there was a lot of winging
Becky: and if you find out who you used to print that would be good to know because I know lots of people have used the [Redacted DPB A] and [Redacted DPB B] and the Centre for Advanced Textiles up in Glasgow
Melissa: I'll find out who it was (later email confirms PrinFab https://prinfab.com/en)
Becky: Thank you that would be great, alright well I'll let you get on. Thank you so much for speaking to me take care of yourself
Melissa: No thank you for speaking to me too, have a good evening
Becky: And I'll speak to you soon I'm sure via email. Cheers Melissa Bye
Melissa: Bye

Dr Phil Henry – Academic Researcher

Interviewee: Dr Phil Henry
Interviewer: Becky Gooby
Date of Interview: 1st December 2016
Method of Interview: Audio Call
Consent given: Yes
Write up approved: Yes
Recording: No Recording – write up devised from notes made at meeting

Duration 45 minutes

Summary
Henry's PhD research developed a colour tool that allowed the user to visually calibrate their print environment and mix digital colours subtractively. The tool was devised to work as a plug in with Adobe Photoshop, but is version dependent and has not been updated for versions post CS6. Colour Mimix aims to develop the user's colour skills by printing a specific set of colours (identified through Henry's research) and then adjusting the screen colour based on the resulting printed colour. This educates the user about screen to print colour changes, and allows them to set up a bank of 24 colours which they know will print as they expect. These colours can then be mixed, mimicking the way colorants mix, on screen to create further colours which, as they are based on the established 24 printable colours, should also print as expected. The software applies colour limitations so that highly saturated, out of gamut colours, may not be selected. Colour Mimix allows the user to build up a colour palette that they may select from in order to feel confident about their printed colour. The tool is limited in that the colour palette process only supports designs which use block colours. Photographic, tonal and images with gradients, which can be printed digitally but are harder to realise with traditional print, are not intended for colour separation and might be made up of hundreds of tones, identification of which would be time consuming. The benefit of such images is that the tonal changes can disguise colour issues as well as disguising colour fading from washing and light exposure.

Henry says that it wasn't until he began working in industry that he understood how important an understanding of colour science, theory and technical issues are for designing. He feels that this lack of understanding presents a barrier to many designers and artists wishing to use their more intuitive design skills in a digital environment. Henry believes that the biggest colour issue in digital textile printing is that software, such as the colour picker tool in Adobe Photoshop, allows the user to select colours from the RGB gamut that are not creatable using a CMYK printer.

Henry frequently encounters students who feel that they are doing something wrong and disappointed because the printed colours are not as they expect rather than blaming the software set up. He believes that it would improve a user's experience if software was designed to work with a designer's 'internal look-up table' and work with existing subtractive colour knowledge. However he is concerned that as software and product development is driven by technology we will continue to see brighter monitor displays that can visualise broader ranges of saturated colours rather than demonstrating physical possibilities.

About
Dr Philip Henry
Lecturer in Design Technology, University of Leeds
Formerly Print Product Manager at NedGraphics
http://colourmimix.co.uk/
http://www.design.leeds.ac.uk/people/phil-henry/
Dr Philip Henry teaches design technology and textile design at University of Leeds. He has a background in industry having worked at NedGraphics, a textile computer systems company, for ten years.

Interview with Dr Phil Henry
Leeds
2pm 1st December 2016

Notes BG made before speaking to PH

Colour Mimix what led you to develop it
Designers experience in colour management
How do designers select colour
Additive – subtractive mixing
Has he come across anything that works
Does he know AVA
Any other colour management software
Does he know Dawson – and the lack of research in gamut mapping on textile substrates
Taste and Fashion – mean you can't say what colour harmony is
Hashe seen Garth Lewis' Virtual Colour Course
Designer education solution to problem?
Artifical Intelligence used to select colour (computer learns from designer selecting - is PH researching that now?

BG introduces herself and asks
What led you to create Colourmimix

PH – took a long time to develop Colour mimix
Started off was woven designed then moved to NedGraphics where he was in charge of software being developed
Believes that science based protocols exclude the designer even though their knowledge on colour is highly developed

PH studied at UMIST whose course is a lot more colour science based
He remembers sitting at back of class thingking I'm a designer why should I be interested in this colour science and theory and technical issues

And this was pre digital textile printing
But then when he was at NedGraphics and working in industry he realised how necessary it was and important into his working environment
The different substrates, colour management systems and yarns and fabric structures
This all transfers to the digital environment

But not having this knowledge is a barrier to you using those intuitive skills in the design process
Barriers are there to artists and designers and other such
These are considered lesser subjects and lesser worth to the superior scientists
But designers have tacit knowledge of colour
Easier way to engage
PH used Characterisation sheets to reduce colours available
Thought about where does the problem come from
Why Create a colour picker tool with the gamut based on RGB screen
What you can re-create doesn't match

When his students are printing out on digital printer

- Novice level people think they've done something wrong
- Designers are having to second guess what it looks like
- Why are you allowed to select colours you cannot use

Designers are having to fall back on intuition again and get a false set of images on screen knowing that the colours they want will be the printable ones and that it translate back onto fabric
The designers 'internal look up table' – I know how this colour will print

So he needed to evidence his intuition

- Subtractive colour is where designers have their knowledge
- So logical outcome is to produce a subtractive colour picker tool

But even still his current experience with students is that they nave no digital colour concepts and knowledge

Students disappointed with their colour outcomes
They feel

- Printer is crap
- They've done something wrong

Screens are luminous bright and maximised to show whats on the screen really well
The computer monitors and software is driven by technology

At leeds the students learn to use the RIP software and the rpinter so that they integrate these skills into their skill set
The technician oversees it and reviews but is not the do-er
It's a hands on approach

PH also dislikes the computer room set up of rows of computers but its placed next door to the studio so that there is a connection to the fabrics and textiles

PH was working at the Mat Lab where he got someone else to do the coding to produce colour mimix
He constantly reevaluated the spec to get the right design
Especially thinking about mimicking human behaviour
For instance when you draw a circle you automatically take your hand off the paper at the end, the programmer didn't take account of this in their coding so the spec was redone

- Key outcome of the tool was to be intuitive
- Colour pick tool takes into account the different substrates and ink types and recharacterises it each time you change one of these variables

It's a controversial piece of software as the accuracy is limited to only a number of colours – not all colours
Its about calibrating the person rather than the machine – the idea being that in understanding how these few colours will print the designer will build up intuitive knowledge of how other colours will print
It's a colour matching exercise

Set up colour tool that represetnts the key colours
Limit colour use
Says – this conditions, this cloth this print then this is the red you will achieve

Aim to bring Planning and forethought into digital print process
Shows that you need to think about the colours

However for photographic images it doesn't work – although with experience you'd get an idea of how they print
Its more of a traditional tool

It does educate on colour expectation

PH talks about Catherine Zoag as a designer who uses digital colour well

By using a limited colour palette colour mimix is mimicking traditional textile printing
The idea is to slow the process down and gain a natural understanding of digital colours
Too many students / designers work fast and therefore carelessly in digital

Interaction between the tacit knowledge and reading of it

PH talks about HCI – human computer interaction

- Values the principles of how humans use computers and says that if something requires a huge manual to know how to operate it then it is not going to be very intuitive
- But by making something intuitive then you reduce the control you have as the human on the machine

PH says again if you remove the colours from the screen that you can't print then you're intuitively using digital colour….. but does this remove your control?

AT Nedgraphics there was a lot of research done on the different substrates (that Dawson says didn't exist) but as it was commercial its not in public domain

They developed software mimicking the characteristics of silk screen printing for the bulk production developed by mixing reactive and different dyes stuffs and creating look up tables that showed you what happened when you layed different inks over different layers, for example the fugitive colours that might appear

PH tested colour mimix with students and did research to see how it changed their working methods
Each group of students were given a brief based on colour trend names such as electric blue, jolly green, vibrant pink. Briefed to use interpretation of colour names but which could be physically printed

One bunch of students were given colour mimix and knowledge of what colours they could print the others weren't

Using the colour picker tool meant students selected more valid colours that were real world ones
However they were disappointed by them and thought they'd not met the brief even though they'd chosen the best colour matches which could physically print

Has PH come across AVA
Yes competitors to NedGraphics and Colour Mimix
Think they are good with their tonal colours and that it sits well in photoghop and mac

PH says that colour fidelity in Mac products are more robust simply because there are less variables (so many types of pcs etc) and apple focus on colour

AVA say they've solved colour issue says BG
PH says well yes at NedGraphics we'd say the same

In laboratory conditions with the right printer, inks, lighting, secondary processes, then yes you have very accurate colour matches
But in real world you don't have those conditions

Everyons is aware that it goes to pot in real world

There is a hierarchy of colour manaamgenet
Profling leverl adds a bit more intervention for accuracy

RGB education is lacking in schools and universities
Cultural intervention

All students / designers should make their screen D65 – day light

There should be a closed loop of colour understanding

Print a palette of every colour with regular progression of lightness and chroma – which is about 365 pages
But this gives only one recipe for one print environment – if you change one variable then you need to adjust your profile

What PH is looking at now is why people who are good with colour struggle with colour on a computer
The CAD barriers that prevent designers utilising their tacit knowledge
He sees the same barriers that existed in the 1990s as he sees now

Other designers PH mentions are
Camille Franceis
Mary Katrin Zoag

Digital Textile printing was not developed as a teaching tool but to build upon exiint knowledge and this extra knowledge has become intermingled and confused

How does PH document his research
Through feedback
Trying to articulate and explain the visual affects of things
Loo at scales of colour back to traditional aesthetics and taste
What are you trying to deliver
What response do you want from people by your work and your design decisions
What are the designers trying to provoke, what emotional responses

BG says I make judgements and evaluations a lot using subjective design responses

PH recommends Itten and the way he breaks down the colour system into dark and light
And quotes him as saying 'you can't make colour masterpieces with unknowledge'

Some designers get sidetracked by the novelty of CAD and digital textile printing such as
- Mirror repeats
- Photoshop filters

Bad aesthetics

The software we use is designed by people who know what they are doing but used by people who don't

Whats happening to Colour Mimix now
Its owned by Leeds uni and only works on CS5 and 6 but can't be developed further without funding
Minolta offered to develop it but only through supporting it with technical resources rather than funding so Leeds university said no

PH is upset by this but stuck
If BG could get a copy of CS5 or 6 PH could get BG a copy to run it
Of maybe send some screen shots

PH suggested AIC conference in Korea as a place BG could send conference papers or posters

BG thanked PH for conversation saying that talking to him validated what she was doing and the research she'd come across to date

Colour Conversations Questionnaires

Questionnaire – Kenny Taylor
Designer and Technician at Chelsea College of Art

Interviewee: Kenny Taylor
Interviewer: Becky Gooby
Date of Interview: 18th July 2017
Method of Interview: Questionnaire
Consent given: Yes

Summary
Kenny said that the course focused primarily on design rather than practicalities. This is partly due to timetabling and budget but also because the course feels that technical issues will be something that students will learn about through experience in industry. However as the set up is not accurate it does provide students with examples of what happens when things go wrong and therefore the need for sampling. He doesn't advise students to rely on colour swatches although these are available because of they are not accurate and will fade.
Their print environment was onl calibrated at installation and they use two profiles with their AVA RIP (Silk and Cotton) and one with their Dye Sub. They do not use a spectrophotometer due to budget restrictions and because they know that their environment is not accurate.

About
Kenneth Taylor is a surface pattern designer and specialist teaching technician at UAL for textiles in DTP.
www.ktaylor-design.com

Questions for Kenneth Taylor

Becky Gooby

18th July 2017

Additional information provided: Information form on Research Project and Consent Form for Research Project

Questions about your own design practice

How would you describe your approach to colour? Do you have an instinctive colour style?

Tend to veer towards blue end of the spectrum, but it depends on the project.

What designers inspire you? Who do you think uses colour well / uniquely?

Many sources of inspiration. I tnd to focus on form above colour, similar to the tessellations of Escher.

Do you have a systematic method for selecting colours in your design practice (for example planning out a colour palette using a colour system such as Pantone) or would you say your colour choices rely upon 'designer's eye'?

It all depends on the project. No single approach.

Do you change your colour choices depending on the substrate or technique you will be using?

Not necessarily

Do you use Computer Aided Design (CAD) in your design practice?

Yes, but I tend to sketch in pencil prior to using digital design tools.

If so what software do you tend to use (for example, Adobe Photoshop, Adobe Illustrator, CoralDraw, AVA)

Photoshop, Illustrator, InDesign mainly

Can you describe your design process (for example, what mediums you might use, whether you begin using hand techniques and incorporate that into a digital file, what methods might you use, are there particular sources of inspiration that you begin with)?

Fluid. My methods depend on the project.

Would you use any of the terms below to describe your design process (please highlight all that apply)?

Tacit X

Haptic

Systematic X

Happenstance X

Experimental X

Planned X

Iterative

Repeatable X

Consistent X

What (if any) processes have you established to achieve colour consistency within the print / production process so that the colours you've envisaged are realised in the final design?

I have learned that the only way to establish colour consistency is to test, test and test. I am now relatively relaxed about color in my own work, unless a specific match is required by a client. (corporate identity for example.)

What sources do you use as colour inspiration? (for example colour forecasting and trends, photographing colours you like, colour systems such as Pantone, objects around you, mood boards, collecting items with colours that you like)

Many sources of inspiration. I now use adobe capture for colour inspiration.

Would you describe colour as critical to your design practice?
No

Do you use colour management software when using CAD (for example embedding particular colour profiles, using a colour management tool such as those supplied by Pantone or use specialist design programs such as AVA which have colour management features)? We have AVA, but do not focus on colour management, as we do not have the resources for this level of accuracy. Additionally, we find it useful not having an ideal system in place as this teaches students that things can go wrong, what to expect and how to prepare a test file.

How do you communicate colour within your production chain (for example do you use a particular colour system such as Pantone to specify your colour choices so digital print bureau has a colour standard to match to, do you provide your own colour samples as a match, do you conduct colour sampling and trials to get the colours as you wanted them)
I created some RGB swatches but advise students not to rely too heavily on colour swatch books as these can fade and the outcome can still shift with different printers. Always request test prints if a s[pecific colour is needed.
Can you tell the difference between a digitally printed fabric and a mechanically rollered or silk screened one? What do you think of digital printed textiles?
Screen prints tend to penetrate deeper into the fabric.
What role do you think digital inkjet textile printing has in the textiles market? (for example is it purely for sampling, one offs, more avant-garde designs, printing photographic imagery, an empowering tool for entrepreneurial designers) Very important role, and is used widely by entreprenurs, avant garde & mass market.

Are you aware of colour issues in digital inkjet textile printing?
Yes
Have you encountered colour issues and if so what measures (if you're happy to share them) did you take to overcome these? (for example consistency issues, translation from design into print and so forth, issues that students you have worked with may have had)
All post production processes (Heat presses/Steaming/washing) affects colour. Different fabrics can also affect how some colours are seen.

Questions about digital print at Chelsea, University of the Arts

How are students educated about the digital print process and the skills required to take a design through to print (for example through workshops given by technicians covering CAD, colour sampling, substrate differences, colour profiling)? Design is the focus on this course, I teach editing skills on photoshop & illustrator, and due to student numbers there is not enough time in the academic calendar to teach deeper technical concerns such as profiling & colour correction. These technical issues tend to be managed by specialist printers in industry, not designers.
How has this course content developed?
It hasn't in this area... due to budget & timetable restrictions.
What digital inkjet textile print equipment do you use at Chelsea? (printer make and model, ink bank colours and ink / dye type)
Mimaki TX2 with Reactive Dyes & Epson F6200 with Disperse Dyes
What secondary processes (for example steaming) are applied?

Star steamer for reactive. (in separate dept) Students do washing at home.
Adkins flat bed heat press for disperse dye printing.
Which Raster Image Processor do you use?
Not sure what you mean by processor? We use photoshop for raster images.
Which Colour Management Software to you use (or is it part of the RIP)?
AVA for reactive and Watsatch for disperse
How frequently is your print environment calibrated?
Only calibrated at time of installation. We have two profiles. (Silk & Cotton)
And a profile for the transfer paper.
Is this done by yourself or by an external company?
By AVA and [Redacted DPB B].
Do you have bespoke colour profiles set up as part of your colour management?
Yes (as above)
Do you conduct your own gamut mapping trials / colour sampling as part of your working practice?
No - We have not purchased a spectrometer initially due to budget restrictions, but we later decided that is more educationally beneficial if we do not have a perfected system.
What substrates do you offer?
Range of silks, cottons & linen
Do you print on velvets? If so have you had any issues with printing upon these (please outline)?No

Do you print on bamboo fabrics? If so have you had any issues with printing upon these (please outline)? Bamboo silk

Are there any particular colours, or images that you know will be problematic to print (for example designs with photographic material)? Any images of reflective objects tend to appear flat. Muted/greyish spot colours can easily shift.

Do you use black compensation to enhance the black content of an image before printing?
No
What colour mode / file format / resolution do you require/recommend CAD files to be in for digital print?
RGB. Tiff. 200ppi
Are students allowed to operate the digital printers or do they observe the technician operating it?
If they are interested, but usually they don't have time and focus more on other aspects of their design work due to limited access to resources.
Are students charged to print their fabrics digitally? If so how much?
We aim to charge reduced/cost price to cover materials & ink.

Questionnaire Melanie Bowles- Academic Researcher Chelsea College of Art

Interviewee: Melanie Bowles
Interviewer: Becky Gooby
Date of Interview: 27th July 2017
Method of Interview: Questionnaire
Consent given: Yes

Summary

Melanie feels that DTP is good for sampling producing small batches or printing to demand. She cited Print Make Wear as an example of entrepreneurial DTP. She said that the expense is challenging and that turning to pigment printing or sublimation printing as opposed to inkjet and reactive dyes is unhelpful because the quality is not good enough. At Chelsea the colour assurance work with students is carried out by the technician although there are colour matching swatches available. The course emphasises that the print facilities available are for sampling and that a DPB would offer a more professional option. She cited post processing as a key impact on colour outcome.

About
Melanie Bowles is the author of Digital Textile Design with Ceri Issaccs which was a revelatory book for me. She also produced a textile design toolbox called Smorgasboard. She has moved into digital embroidery
http://www.melaniebowles.co.uk/melanie_bowles.html

Questions for Melanie Bowles

Becky Gooby

27th July 2017

Additional information provided: Information form on Research Project and Consent Form for Research Project

How would you describe your approach to colour? Do you have an instinctive colour style?
I have an instinctive colour style often influenced by my surroundings and 'Finding colour'
My approach is playful using painted papers of fabrics to create palettes.

What designers inspire you? Who do you think uses colour well / uniquely?
I tend to look at artists, graphics and product for colour, less so textiles. I like clean colour, at the moment I am looking at Nathelie du Pasquier and Nicholas Party, I find artists on Instagram and social media which will led me to there work. I like the way you can curate on Instagram, its instant and to the point.

Do you have a systematic method for selecting colours in your design practice (for example planning out a colour palette using a colour system such as Pantone) or would you say your colour choices rely upon 'designer's eye'?
I work like an artist, I don't plan but I am instinctive – I like to discover and enjoy surprise's, it's part of the enjoyment of creating new work.

Do you change your colour choices depending on the substrate or technique you will be using? (for example are there particular colour constrictions that you need to consider for digital embroidery?)
When I digitally embroider I have to select yarns, which are beautiful as they all have difference qualities – such as shiny colour, matt colour. The embroidery builds colour depth and richness.

Do you use Computer Aided Design (CAD) in your design practice?
Yes a design and conversion tool.

If so what software do you tend to use (for example, Adobe Photoshop, Adobe Illustrator, CoralDraw, AVA)
I use Illustrator and Pulse embroidery software and Indesign for graphic communication. I rarely use Photoshop.

Can you describe your design process (for example, what mediums you might use, whether you begin using hand techniques and incorporate that into a digital file, what methods might you use, are there particular sources of inspiration that you begin with)?
I mainly start with hand processes, it's important that my work has physical content. I struggle when working purely digital unless I have a developed a clear identity. Once my designs have been developed I use the computer as a tool and a process for production, ie – Illustrator – digital embroidery. My work has strong graphic/branding content for communication purposes.

Would you use any of the terms below to describe your design process (please highlight all that apply)?
Tacit

Haptic
Systematic
Happenstance
Experimental
Planned
Iterative
Repeatable
Consistent

What (if any) processes have you established to achieve colour consistency within the print / production process so that the colours you've envisaged are realised in the final design?

What sources do you use as colour inspiration? (for example colour forecasting and trends, photographing colours you like, colour systems such as Pantone, objects around you, mood boards, collecting items with colours that you like)
I collect colour through finding colour, this can be object's or flat colour as well as yarns I arrange them to make palettes. I also look at trends and catwalk for inspiration. I don't copy a trend. My colour is often about discovery. I also visit the Albers collection at the University for understanding of colour.

Would you describe colour as critical to your design practice?

Have you had any issues with colour (whether to do with consistency issues, translation from design into print and so forth) that you could share?

Do you use colour management software when using CAD (for example embedding particular colour profiles, using a colour management tool such as those supplied by Pantone or use specialist design programs such as AVA which have colour management features)?

How do you communicate colour within your production chain (for example do you use a particular colour system such as Pantone to specify your colour choices so that the mill / dye lab / manufacturer / digital print bureau has a colour standard to match to, do you provide your own colour samples as a match, do you conduct colour sampling and trials to get the colours as you wanted them, do you use a colour database program such as Natific which uses colour measurement to establish colour specifications)

Can you tell the difference between a digitally printed fabric and a mechanically rollered or silk screened one? What do you think of digital printed textiles?

Yes, - screen print has depth to the colour and digital printing is surface colour. They offer very different qualities and one has to experiment with fabrics to reach the quality they are looking for. I am recently printing on linen's which offers a more artisan feel.

What role do you think digital inkjet textile printing has in the textiles market? (for example is it purely for sampling, one offs, more avant-garde designs, printing photographic imagery, an empowering tool for entrepreneurial designers)

Digital printing offers an opportunity to sample and produce small batches of products due to print on demand. So as a good production for start ups – see introduction of Print Make Wear by Emma Neuberg for its context and opportunity for the craft sector. It offers all the above that you mention. It's downside is that it is still expensive. Some bureau offer cheap options such as pigment printing and sublimation, which often feels and looks cheap. I have noticed this is an option chosen by students due to economics rather than quality of cloth.

Are you aware of colour issues in digital inkjet textile printing?
Yes, but I don't really work with them. The technician at work tests for students that have colour specifications.

Have you encountered colour issues when digitally printing your work and if so what measures (if you're happy to share them) did you take to overcome these?
As above, the technician will test for a student we also have a colour/matching swatches on different fabrics to guide students. We always emphasize, the bureau at college is for sampling not for a main production. If students want a more professional service they out source so they can work with the printer.

Do you avoid certain colours in designs that are intended for digital print because you know they may be problematic?

My aim is to create a tool kit for designers and SMEs to utilise so that they can have a better understanding of digital textile printing and the variables involved that affect colour. With your experience of creating tool boxes and activities that encourage and support a participatory approach to design education and exploration (The People's Print, Smorgasboard) what advise would you give me about putting together a successful resource?

I suggest Collaborate with a printer and produce a colour swatch/pantone for the designer to match with. I believe Spoonflower offer one to their consumer.

Toolboxes have to have a strong and user-friendly graphic identity, so they are easy and attractive to use.

As I am not a technician I am not sure how this would apply to different print bureaus as the post process has environmental factors, which can change colour.

Questionnaire – Rachel Reynolds Designer and Technician at Winchester College of Art

Summary

Interviewee: Rachel Reynolds
Interviewer: Becky Gooby
Date of Interview: 29th March 2017
Method of Interview: Questionnaire
Consent given: Yes

Rachel has experience of printing both her own designs and working as a technician at Winchester School of Art. She adjusts her designs depending on what manufacturer she is using, using profiles, colour samples and test prints. She has seen the development of DTP and improvements in print quality and colour. She feels it is a practical and financially viable business model for SMEs to print small batches and produce a range of products. Once she is confident with the colour outcome she is happy to hand over production to the DPB.

At Winchester they have had issues with printing black but have used post processing (steaming and washing) to aid for example black prints on velvet. Students are given hand outs and instructions for providing artwork. Student's artwork is not altered by the technician and printed as is. Students do their own steaming and washing but do not operate the printer. They are inducted in DTP by the technicians which includes workshops on colour, colour matching and paper to fabric. They are advised to create test strips usually a 10cm print, as they develop their design ideas.

About

Rachel Reynolds is a textile designer and the technician at Winchester School of Art of DTP
https://www.rachel-reynolds.co.uk/

Questions for Rachel Reynolds

Becky Gooby

29th March 2017

Additional information provided: Information form on Research Project and Consent Form for Research Project

Questions about your own design practice

How would you describe your approach to colour? Do you have an instinctive colour style? Colour plays a crucial part in the process of creating a piece/s of work, from research to finaldesign. A typical project starts with primary research, where I view the subject matter first-hand, making initial sketches and taking photographs which I'm drawn to instinctively (usually texture, pattern, colour and form of nature and architecture). A host of colour in nature is a good indicator of what works together. Back in my studio I then work from thisresearch by drawing out the images and colours that sit well together and form a colour palette. I then add complimentary colours, resulting in a colour board.

What designers inspire you? Who do you think uses colour well / uniquely?

I'm inspired by both designers and artists for colour, ranging from those that use bold brightcolours through to delicate softer palettes such as; Andy Goldsworthy, Trisha Guild / Designers Guild, Lucienne Day, Howard Hodgkin, Josef Albers, Sara Midda.

Do you have a systematic method for selecting colours in your design practice (for example planning out a colour palette using a colour system such as Pantone) or would you say your colour choices rely upon 'designer's eye'?

Keeping an eye on colours that are on trend is important for a designer but as someone who produces small bespoke ranges the longevity of my colours need to be considered. The freedom to not be limited by a 3-5 colour way palette (such as screen printing) is liberating and having a vast number of colours to use in creating a design for digital printing is a joy!

However sometimes having a limited number of colours simplifies the colour selection process and produces beautiful colour results. I tend to combine using hand painted coloursthat I scan into the computer to create my own colour palette and at other times I'll matchthese to Pantone Colours or the colour picker in Photoshop and set a collection to these colours.

Do you change your colour choices depending on the substrate or technique you will beusing?

Yes, a screen-printed design on fabric will be limited to a 3- 5 colour way. A digital design for fabric or wallpaper will have more shades and tones of varying unlimited colours. When I create my digitally printed Perspex pieces consideration for light, shadow and transparency all come into the decision making of choosing the right colours.

Do you use Computer Aided Design (CAD) in your design practice?

Yes. My designs are made up of drawings, screen prints, block prints, dyed fabrics, photographs and hand painting. I scan these into the computer and develop further (ratherlike a collage) using Adobe Photoshop.

If so what software do you tend to use (for example, Adobe Photoshop, Adobe Illustrator,CoralDraw, AVA)maing of
Adobe Photoshop

Can you describe your design process (for example, what mediums you might use, whetheryou begin using hand techniques and incorporate that into a digital file, what methods might you use, are there particular sources of inspiration that you begin with)?
As above.

I love to combine traditional hand printed and painted techniques with digital printing. Being able to enhance and combine dyeing techniques with repeat patterns and photography, working to any scale, creating layers of colours and transparencies and thenhaving the accessibility of taking that design and digitally printing onto a number of surfaces, fabrics for artwork or products, inspires me!

Would you use any of the terms below to describe your design process (please highlight allthat apply)?
Tacit
Haptic
Systematic
Happenstance
Experimental
Planned
Iterative
Repeatable
Consistent

(I know a bit of a mix there!) I like to 'see what happens' at various stages of the design-to-print stage.

What (if any) processes have you established to achieve colour consistency within the print / production process so that the colours you've envisaged are realised in the final design?
I spent a long time sourcing digital manufacturers and getting printed samples of my designsbefore I was happy with the colour result. I have found a company that prints both my wallpaper and fabrics, which allows parity across those products. The challenge is knowing the outcome from screen, to print on your own printer and then after sending the design to a manufacturer's printer and being sure of the final colour result.

What sources do you use as colour inspiration? (for example colour forecasting and trends, photographing colours you like, colour systems such as Pantone, objects around you, mood boards, collecting items with colours that you like)
As before; Primary research, and Secondary (forecasting trends, magazines, books, artists) from which I create a mood board, then a colour board, then development work, then design/s sometimes a set of alternative colourways of the same designs are required (whereapplicable).

Would you describe colour as critical to your design practice?
Yes, you can have a good design, but the wrong colourway can do nothing for it. Both are needed in equal measure.

Do you use colour management software when using CAD (for example embedding particular colour profiles, using a colour management tool such as those supplied by Pantone or use specialist design programs such as AVA which have colour managementfeatures)?
A range of my products are printed with different manufacturers, I have to produce the digital designs according to their software and colour space profiles. Before going ahead with a 'small run' of printed designs, I always have test print samples done first and a hardcopy of their colour samples printed so I have it as a reference.

How do you communicate colour within your production chain (for example do you use a particular colour system such as Pantone to specify your colour choices so digital print bureau has a colour standard to match to, do you provide your own colour samples as a match, do you conduct colour sampling and trials to get the colours as you wanted them)It depends on cost! So far I've done the above.

Can you tell the difference between a digitally printed fabric and a mechanically rollered orsilk screened one? What do you think of digital printed textiles?
Yes. The number of colours in the design can be an indicator, however the look and touch ofthe surface of the printed fabric is normally the difference between them.

What role do you think digital inkjet textile printing has in the textiles market? (for example is it purely for sampling, one offs, more avant-garde designs, printing photographic imagery, an empowering tool for entrepreneurial designers)
It's developing all the time, the quality of print and colour is getting better and it is a practical and financially viable choice for small independent businesses to progress, extendand develop their product line in small batch quantities over a wide range of products.

Are you aware of colour issues in digital inkjet textile printing?
My experience has only been in colour matching and being confident in handing over theregins to someone else for the final stage of the printing process.

Have you encountered colour issues and if so what measures (if you're happy to share them) did you take to overcome these? (for example consistency issues, translation from design into print and so forth, issues that students you have worked with may have had) From creating the paper design, to the screen, to printing the colour samples myself prior tosending artwork to the manufacturers, all have their own colour issues that require attention and patience. I work with a printer who receives a hard copy of the design alongside the digital file to get the best result.

Questions about digital print at Winchester
What digital inkjet textile print equipment do you use at Winchester? (printer make andmodel, ink bank colours and ink / dye type)
Mimaki TX2 1600, Reactive Dyes

What secondary processes (for example steaming) are applied?
Students are trained to use a steamer for both digital and screen printed fabrics.

Which Raster Image Processor do you use?

Which Colour Management Software to you use (or is it part of the RIP)?How

frequently is your print environment calibrated?

Is this done by yourself or by an external company?Externally

Do you have bespoke colour profiles set up as part of your colour management?Yes

Do you conduct your own gamut mapping trials / colour sampling as part of your workingpractice?
When we can!

What substrates do you offer?Cottons,
Silks, Jersey, Velvet

Do you print on velvets? If so have you had any issues with printing upon these (please outline)? Yes, furnishing velvet. Black can be an issue when printing, but we ensure thatstudents steam and wash the velvet correctly for it to fix properly with beautiful results.

Do you print on bamboo fabrics? If so have you had any issues with printing upon these(please outline)? No

Are there any particular colours, or images that you know will be problematic to print (forexample designs with photographic material)?
As long as students are aware of the correct resolution for photographic submissions theyprint well. Black can sometimes be problematic / heavy when printing.

Do you use black compensation to enhance the black content of an image before printing? We don't tend to change any of the student's files once they have been sent to us for printing. Clear inductions, handouts and information is provided and the university websiteis always on hand for students to view before submitting their finished PDF file.

What colour mode / file format / resolution do you require/recommend CAD files to be infor digital print?
RGB/PDF/300 dpi

Are students allowed to operate the digital printers or do they observe the technician operating it?
No, for health and safety reasons only trained staff can use the Mimaki andstudents aren't allowed to come into contact with the printer.

The training in digital print that students from Winchester have spoken about seems to be very comprehensive. How are students educated about the digital print process and the skills required to take a design through to print (for example through workshops given by technicians covering CAD, colour sampling, substrate differences, colour profiling)?
The students are inducted by technicians for using CAD with the Mimaki. We give comprehensive workshops on colour, colour matching from screen to print and from paperto fabric. All students are advised to become familiar with the Mimaki and begin to create test strips (10cm) as they develop colours and ideas alongside their sketch book work. This gives a basis for students as their work develops for when they are ready to work and digitally print larger pieces of fabrics for varying outcomes.

How has this course content developed (for example when did Winchester begin to embed digital print into the curriculum – this may be more of a question for the academic team but thought I'd ask in case you knew) The Mimaki printer has been in place for approximately 10 years. Winchester School of Art provides both traditional screen printing facilities and workshops alongside digital printing and sees the positive benefits of the crossover in using both of these techniques.

Are students charged to print their fabrics digitally? If so how much?
The fabric prices range from £30 --- £42 per metre, students can order less and the minimumorder is a 10cm test strip.

Questionnaire Trish Belford- Academic Researcher

Interviewee: Trish Belford
Interviewer: Becky Gooby
Date of Interview: 7th March 2017
Method of Interview: Questionnaire
Consent given: Yes

Summary
Trish cites substrates, metamerism, lack of equipment, coatings, print head malfunctions and differing colour sources as issues in colour outcome for DTP

About
Trish Belford set up Belford Prints, a screen printing company producing fabrics for high end fashion coture. As the industry evolved and digital processing (design and print) became more prolific she moved into academic research and has several projects which she disseminates on Instagram. She worked in concrete designing and setting up Tacitiliy Factory. She recently collaborated with Duncan at Earthed Fabrics

I wanted to interview her because of her experience as a textile designer and the work she did for the Colour Coded research project
https://materialdistrict.com/material/tactility-factory/
https://www.instagram.com/alchemyofprint/
https://www.instagram.com/lockdown_alchemy/
https://earthedbywmclark.co.uk/collection/the-donacloney-collection/

Questions for Trish Belford

Becky Gooby

7th March 2017

Additional information provided: Information form on Research Project and Consent Form for Research Project

How would you describe your approach to colour? Do you have an instinctive colour style?
I WOULD APPROACH COLOUR FROM A INSTINCTIVE PERSPECTIVE AND ALSO AIM TO TEACH COLOUR IN THE SAME WAY, BUT THIS DEPENDS ON THE CAPABILITY OF THE STUDENT. I FIND A VERY PRESCRIPTIVE COLOUR PALETTE CAN BE UNINSPIRING.

What designers inspire you? Who do you think uses colour well / uniquely?
MARIMEKO – SIMPLE BOLD COLOUR PALETTE WITH SOME ELEMENT OF SURPRISE
JOSEF FRANK – AND YES THIS IS VERY CURRENT DUE TO THE RECENT SHOW AT THE TEXTILE MUSEUM BUT I HAVE BEEN A BIG FOLLOWER FOR YEARS, HE IS INSTINCTIVE, BUT SO BALANCED. A GENIUS
GEORGINA VON ETZDORF – PROBABLY THE BEST TEXTILE SCARF DESIGNER COLOURIST THAT I HAVE EVER WORKED WITH. SHE ALWAYS PAINTS COLOURWAYS ON BROWN PAPER AND RARELY IF NEVER USES BLACK . A PAINTERLY APPROACH TO TEXTILE DESIGN. WHEN DIGITALLY PRINTING SOME OF HER DESIGNS TO GET THE CORRECT SENSE OF COLOUR SHE WANTED THE PRINTS HAD TO BE SEPARATED AS OFTEN SONE OF THE SHADES WERE OUT OF GAMUT AND HENCE LOOKED TOO PHOTOSHOPED

Do you have a systematic method for selecting colours in your design practice (for example planning out a colour palette using a colour system such as Pantone) or would you say your colour choices rely upon 'designer's eye'?
DESIGNERS EYE – WORKING FRO MAGAZINES, FABRIC SAMPLES TO CREAT MY OWN PALETTE THEN MIX THE SHADES TRADITIONALLY – NOTHING DIGITAL IN MY PRACTICE

Do you change your colour choices depending on the substrate or technique you will be using? (for example are there particular colour constrictions that you need to consider for shadow tissue weaving, or for fabrics that will become part of the infused concrete ranges produced by Tactility Factory)
SHADOW TISSUE WEAVING REQUIRES STRING SHADES TO INITIATE THE PROCESS AS THE COLOUR DROPS BY 50% DUE TO THE WEFT INSERTION, BUT THIS CAN ALSO HAVE A CONTRASTING RESULT – HAVE TO WORK WITH THE ACTUAL PROCESS OF DYEING YARNS AND WEAVING IN ORDER TO GENERATE THE COLOUR PALETTE, IT WILL NOT REPRODUCE IN CAD
TACTILITY FACTORY TEXTILES HAVE TO WORK WITH THE CONCRETE – AND HAVE AN ONGOING DISCUSSION ABOUT THE MERITS OF YELLOW VELVET IN CONCRETE – I HATE IT BUT MY ARCHITECT PARTNER LOVES IT!!! – RED IS A DIFFICULT COLOUR TO WORK WITH DUE TO THE DISPERSION OF THE DYE AND CAN 'SHOW' THROUGH, THEREFORE OUR COLOUR CONCLUSIONS ARE DRIVEN IN PART BY THE LIMITATIONS OF THE PROCESS. THE TEXTILE COLOUR AND THE CONCRETE GREY HAVE TO WORK TOGETHER AS ONE OR CONTRAST IN A YIN AND YANG WAY

Do you use Computer Aided Design (CAD) in your design practice?
I GENERATE THE DESIGNS BY HAND AND THEN THEY ARE TRANSLATED VIA CAD BY A CAD EXPERT, CAD IS THE TOOL TO THE END FOR ME NOT THE START POINT.

If so what software do you tend to use (for example, Adobe Photoshop, Adobe Illustrator, CoralDraw, AVA)
ILLUSTRATOR BUT AVA IS EXCELLENT FOR TEXTILE DESIGN REPEAT

Can you describe your design process (for example, what mediums you might use, whether you begin using hand techniques and incorporate that into a digital file, what methods might you use, are there particular sources of inspiration that you begin with)?
HAND SCREEN PRINTING / HAND CUTTING PAPER STENCILS

Would you use any of the terms below to describe your design process (please highlight all that apply)?
Tacit
Haptic
Systematic
Happenstance
Experimental
Planned
Iterative
Repeatable
Consistent

What (if any) processes have you established to achieve colour consistency within the print / production process so that the colours you've envisaged are realised in the final design?
ACCURATE RECIPE BOOK WITH ALL WEIGHTS TIME AND TEMPERATURE RECORDED

What sources do you use as colour inspiration? (for example colour forecasting and trends, photographing colours you like, colour systems such as Pantone, objects around you, mood boards, collecting items with colours that you like)
MAGAZINE CUTTING / FABRIC SWATCHES

Would you describe colour as critical to your design practice?
THINK COLOUR IS IMPERATIVE TO ALL DESIGN PRACTICE

Have you had any issues with colour (whether to do with consistency issues, translation from design into print and so forth) that you could share?
DIFFEREING BATCHES OF CLOTH CAN TAKE UP COLOUR DIFFERENTLY.
CUSTOMER PROVIDING A CUTTING AND THEN I MATCH BUT IF THE MATCH IS SENT AWAY ELSEWHERE IT MAY BE VIEWED IN A DIFFERENT LIGHT – EG I MATCH IN DAYLIGHT AND CUSTOMER VIEWS IN ARTIFICIAL LIGHT.
VELVET WHICH I USE A LOT TAKES THE COLOUR DIFFERENTLY DEPENDING ON THE WAY TO NAPP RUNS
METEMERIC COLOUR CHANGES IN BEIGE TONES ALWAYS PROBLEMATICAL

Designers working with digital inkjet textile printing frequently have to adjust their CAD files to anticipate colour changes depending on the substrate they are intending to print upon. What adjustments might a designer need to make when intending to print using more traditional print processes (for example rotary or screen printing) and would the substrate need to be taken into account when making these adjustments ? (sorry slightly wooly question, I suppose I'm trying to establish whether designers need to tailor their designs for every type of print process and substrate or would that be done by the dye house, mill, printers for traditional methods so is unique to digital print)
DESIGNERS PROBABLY DON'T HAVE THE NECESSARY EQUIPMENT TO GET CORRECT COLOUR MATCHES – SUBSTRATE ALWAYS VARIES THE COLOUR

Do you use colour management software when using CAD (for example embedding particular colour profiles, using a colour management tool such as those supplied by Pantone or use specialist design programs such as AVA which have colour management features)?
NO

How do you communicate colour within your production chain (for example do you use a particular colour system such as Pantone to specify your colour choices so that the mill / dye lab / manufacturer / digital print bureau has a colour standard to match to, do you provide your own colour samples as a match, do you conduct colour sampling and trials to get the colours as you wanted them, do you use a colour database program such as Natific which uses colour measurement to establish colour specifications)
NOT REALLY RELEVANT TO ME ANYMORE

Can you tell the difference between a digitally printed fabric and a mechanically rollered or silk screened one? What do you think of digital printed textiles?
YES THE COLOUR SATURATION ON SCREEN PRINTED FABRICS IS BETTER AND THE BACK IS BETTER (SOME DIGITAL PRINT COMPANIES WOLD DISAGREE BUT I CAN TELL THE DIFFERENCE)

What role do you think digital inkjet textile printing has in the textiles market? (for example is it purely for sampling, one offs, more avant-garde designs, printing photographic imagery, an empowering tool for entrepreneurial designers)
NO RESTRICTION ON COLOURS AND AVAILABILITY OF BLENDED TONAL SHADES

Are you aware of colour issues in digital inkjet textile printing?
IN THE PAST I EXPERIENCED MANY BUT SUSPECT THIS HAS IMPROVED BUT THE CRITICAL FACTOR WOULD BE THE PRE PREPARATION OF FABRIC WHICH NEEDS TO BE CONSISTANT. THIS WILL BE IMPROVING WITH THE INTRODUCTION OF DIGITAL PIGMENTS

If you have used digital inkjet textile printing as a means of printing your work have you encountered colour issues and if so what measures (if you're happy to share them) did you take to overcome these?

IN MY PAST BUSINESS THERE WERE LOADS OF COLOUR ISSUES – INCONSISTENT COATING / BLOCHED HEADS BEING THE MAIN ONES BUT AS I DON'T SPECIALISE IN DIGITAL PRINTING ANHY MORE THIS IS NOT REALLY RELEVANT

Example Information Form and Consent Form

Information Form

Research Project: The development of methodologies for digital colour printing in textile design, through an understanding of an interwar historical colour palettes.

Researcher: Becky Gooby
Supervisor: Professor Carinna Parraman

About this project

I am a PhD researcher at the University of the West of England studying issues with colour in digital textile printing. My research inquiry investigates the difference between screen-colour and print-colour, and considers the ways a designer might overcome colour accuracy problems. I will create an online tool kit which will provide designers with methods and resources to feel confident with their colour use in digital textile printing. This will be published at www.digitaltextilecolour.org
The inquiry set outs to articulate the research through the following aims and objectives:

Aims

- to create a tool kit, accessible to artists, textile practitioners and similar, without access to commercial resources and chemical colour knowledge/ science, which provides guidance to assuring a colour match when printing from ink jet digital printers on to fabric
- to investigate creating an historical digital colour palette that re-creates colours from the interwar period, in digital print on fabric

Objectives

- review the existing literature on colour expectation in textile design for digital print
- put together a network of experts to facilitate colour conversation case studies
- establish a coherent body of colour work using digital textile printing
- identify historical colours from archival and primary sources
- create a historical archive of colour use in the British domestic interior (1918-1939)

The research project will be addressed through two fields of inquiry – Colour Expectation and Colour Archive, and encompass several research questions.

Colour expectation

- RQ1 What measures must a designer take to feel confident with their colour use in digital printing on cloth?
- RQ2 How can scientific colour theory and production methods for digital printing be understood and utilised by the design community?

Colour archive

- RQ3 How can historical colour use inform colour aesthetics in digital print on cloth?
- RQ4 How did colour use develop in the British domestic interior of the Interwar period?

Information Form

Research Project: The development of methodologies for digital colour printing in textile design, through an understanding of an interwar historical colour palettes.

Researcher: Becky Gooby

Supervisor: Professor Carinna Parraman

What am I being asked to do?

Participate in an informal 'Colour Conversations' which will form part of an ongoing dialogue with the Researcher about colour. You will be asked questions such as how you use colour in your work, how do you make choices about colour, and what colours are you drawn to. The conversations will be between yourself and the Researcher, on a one-to-one basis, and last no more than an hour.

The conversations will be recorded (audio) and subsequently transcribed. You will be sent copies of the transcriptions and asked to confirm their accuracy. The content will be used as Case Studies to inform my research inquiry and become part of my doctoral thesis.

The intention of the Colour Conversations series is to build up a body of knowledge on colour usage in digital textile print which will inform and support my research work around colour expectation and creating a colour archive.

Terms & Conditions

The consent form you are being asked to sign will be stored on a password protected laptop accessible only by the Researcher and transferred to a dedicated external hard drive at the end of this research project, kept at the Researcher's home. The consent form asks whether you are happy for your data and contribution to be referenced in future work by the Researcher. You do not have to agree to this but may still take part in the interview series.

The audio files will be destroyed and the transcriptions stored on a password protected laptop, accessible only by the Researcher. At the end of the project they will be transferred to a dedicated external hard drive which will be stored in the Researcher's home. You may request that the transcripts are redacted prior to the thesis being made publically available.
Withdrawal policy - as this conversation is visualised as an ongoing dialogue, participants will be asked verbally before and after a conversation whether they are happy to continue. A fixed, final withdrawal date will be agreed between the participant and researcher, as the Case Studies are key to the research. Up to this point you may withdraw at any time without being required to give a reason.
You may request for your data and contribution to be anonymised or pseudonymised.
If you have any questions you'd be very welcome email them using the contact details in the header.

Consent Form

Research Project: The development of methodologies for digital colour printing in textile design, through an understanding of an interwar historical colour palettes.
Researcher: Becky Gooby
Supervisor: Professor Carinna Parraman

1. I confirm that I have read, and understand, the information sheet dated **……**(version **1)** about the interview I am taking part in. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw, without giving any reason up until a fixed date*, which I will be consulted upon. ☐
3. I understand that data collected during the study and the content of the interviews, may be used as part of the above research project and may be referenced in future projects and publications and agree to this. ☐
4. I understand that I may at any opportunity, up until the submission of the thesis, ask to be anonymised or pseudonymised and that I may request for transcripts to be redacted before information is made publically available. ☐
5. I agree to take part in the above study. ☐

Name of Participant	Date	Signature
Name of Person taking consent.	Date	Signature

*Agreed Date, after which withdrawal from participating in this research study is no longer an option. If you would like to withdraw from this study please contact

Appendix G
Interwar Case Study

This appendix features documentation and analysis from the Interwar Case Study.

1. Exhibition Hand Out - accompanying handout to the Exhibition of Practice detailing inspiration, body of work and analysis P1-18
2. Body of work and Analysis of the Colour Reference Book P19-28
3. Body of work and Analysis of the Digital Lab Dip Tests / Colour Maps p29-31
4. Body of work and Analysis of the Indicator Substrates Profiles p32-37

Interwar Case Study Handout

By Becky Gooby
3D3 Doctoral Researcher

Inspiration

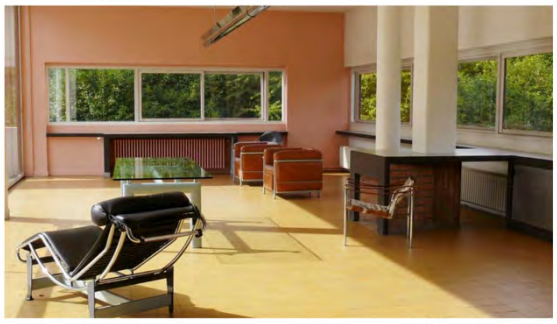
An Exploration of Colour Use in the British Interwar Period and a Response through Textile Practice

Becky Gooby
Centre for Fine Print Research
UWE, Bristol, UK

Svrie Maughm Interior

The 1930s Home
Greg Stevenson

Derek Patmore
Colour Scheme for the Modern Home
1936



Le Corbusier
Villa Savoye, Possey France

An Art Nouveau Stairwell in Paris

A surrealist interior London

The interior of Walter Gropius' Office
Bauhaus

A coat by Paul Poiret

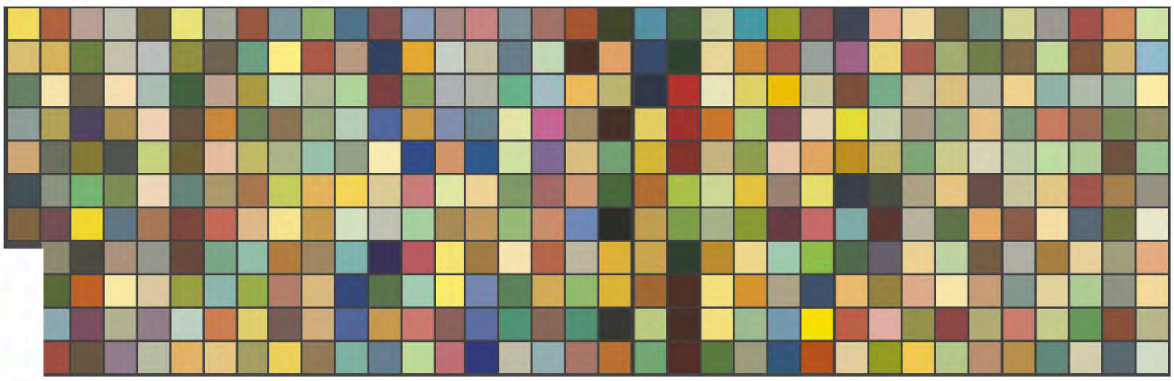
Fashion Garments by
Sonia Delaunay

A Josef Hoffman / Wiener Werkstatte
Interior

Shrubbery
The first silk screen print by Warner and Son

An illustrative style silk screen print by
Warner and Son. Silk screen enabled fine lines to be used

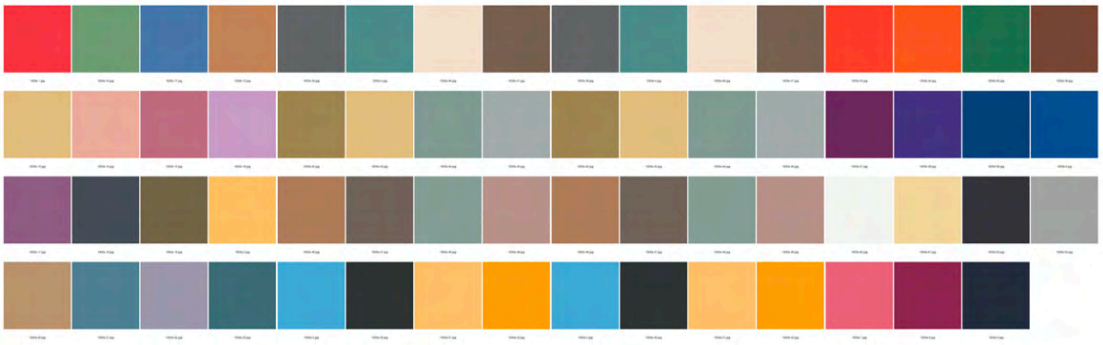
Initial Colour Palettes



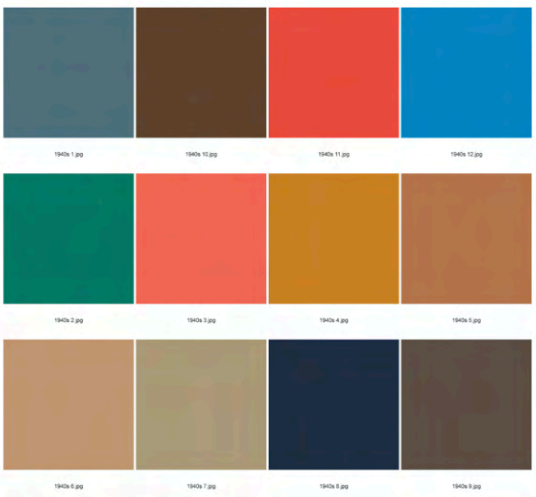
ASE Colour swatch file using spectrophotometer measurements of paint charts from 1920s and 30s

Pantone 1910s

Pantone 1920s

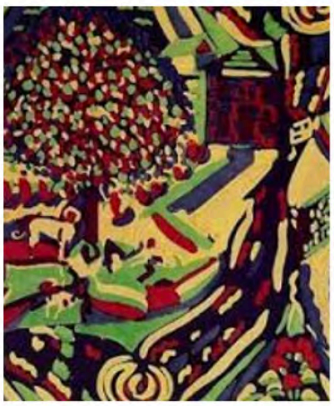


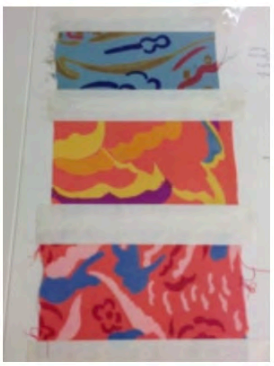
Pantone 1930s



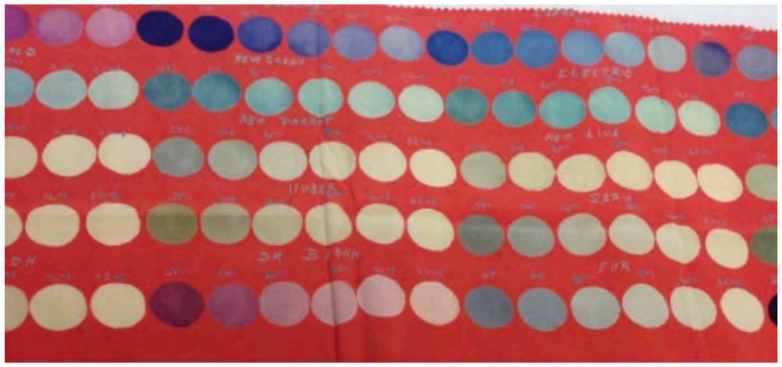
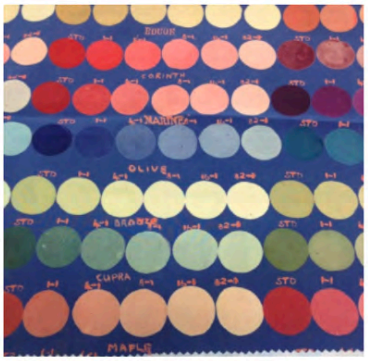
Pantone 1940s

CRYSEDE

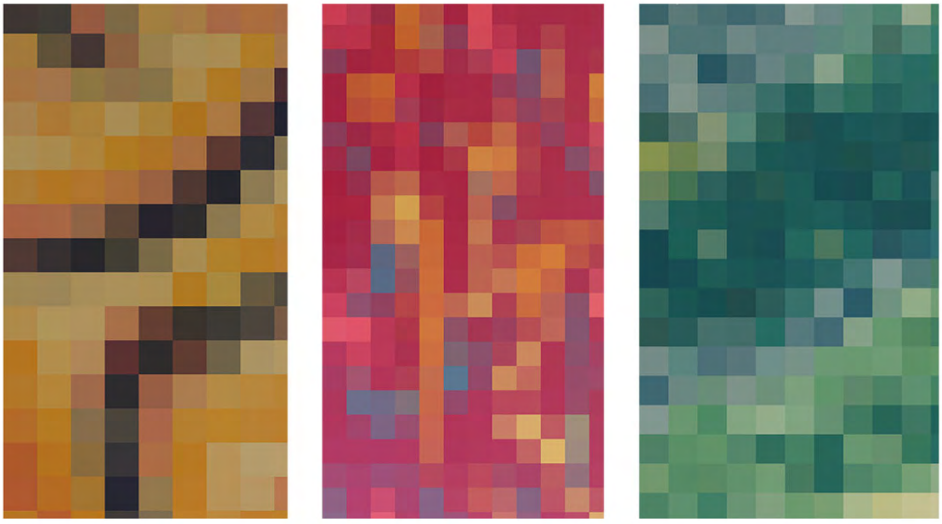




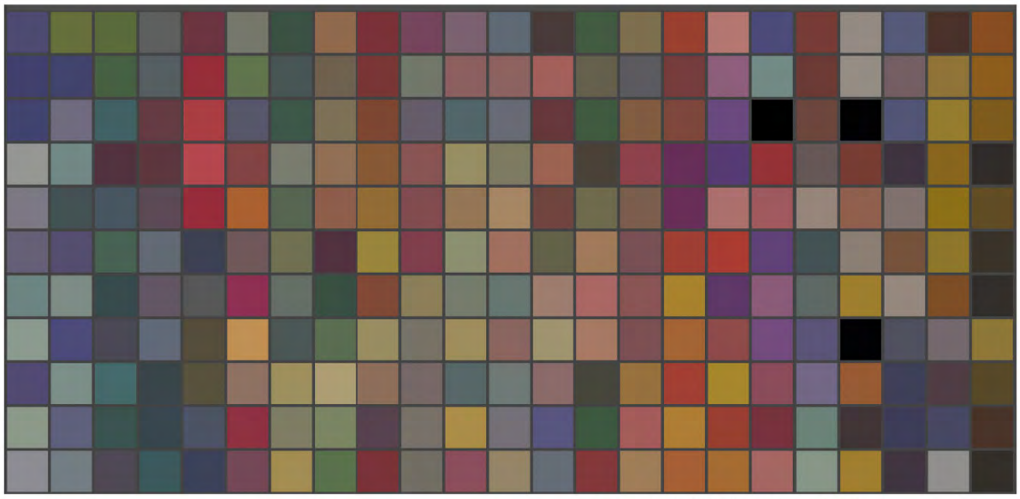
Crysede Swatch Book

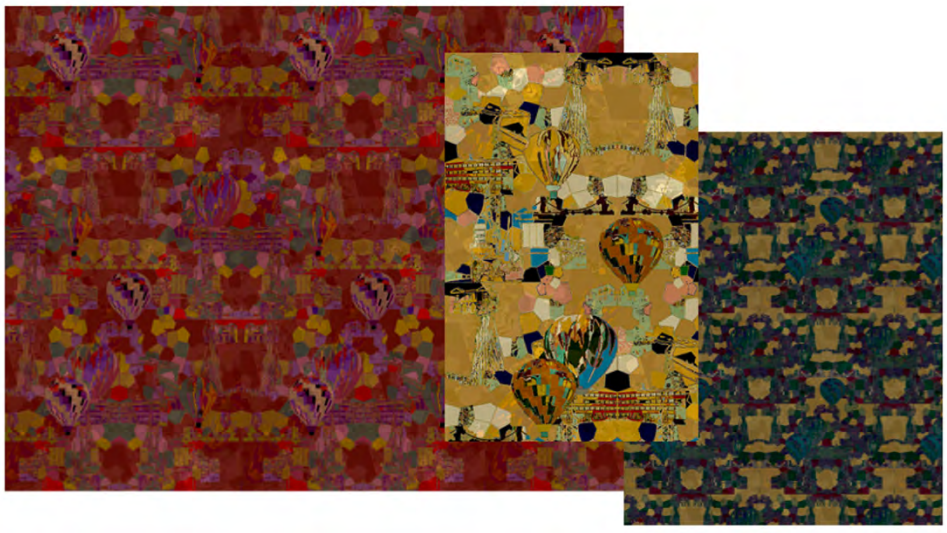
Crysede Colour Charts



Crysede Colour Studies



Crysede ASE Colour Swatch File
Made using spectrophotometer measurements
Of the colour studies

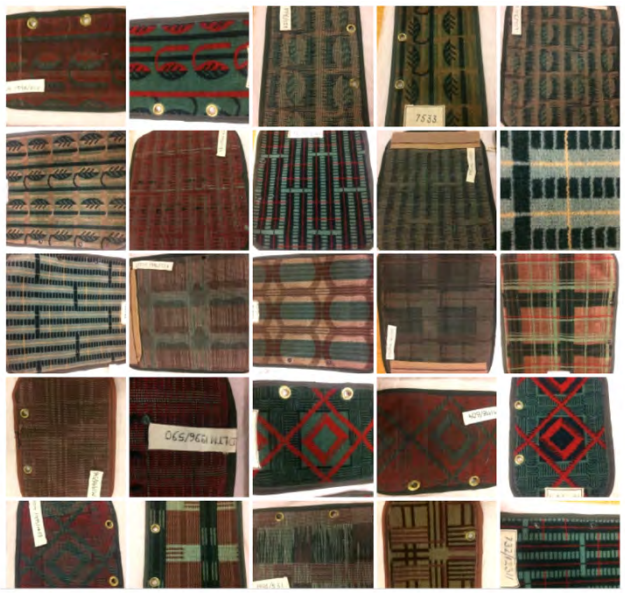


Design response to Crysde archive
Using ASE Colour Swatch to create colourways

EILEEN HUNTER

Design Response to Hunter archive Colourways created using ASE Swatch file
From Anatomy of Colour Paint Charts

LONDON PASSENGER TRANSPORT BOARD



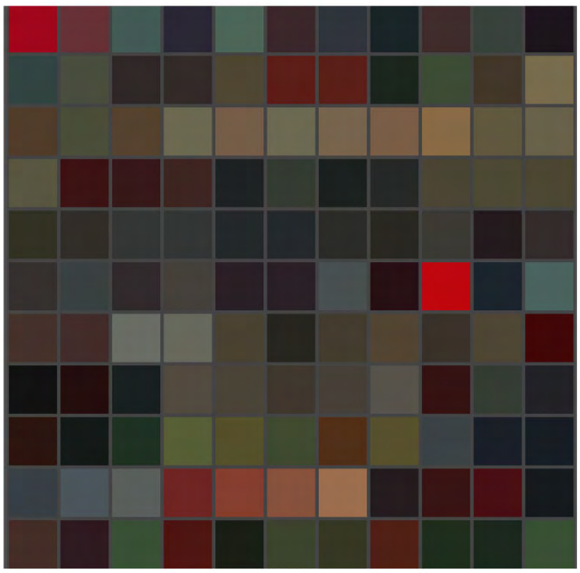
Transport poster commissioned
By Frank Pick

Paul Nash Design work

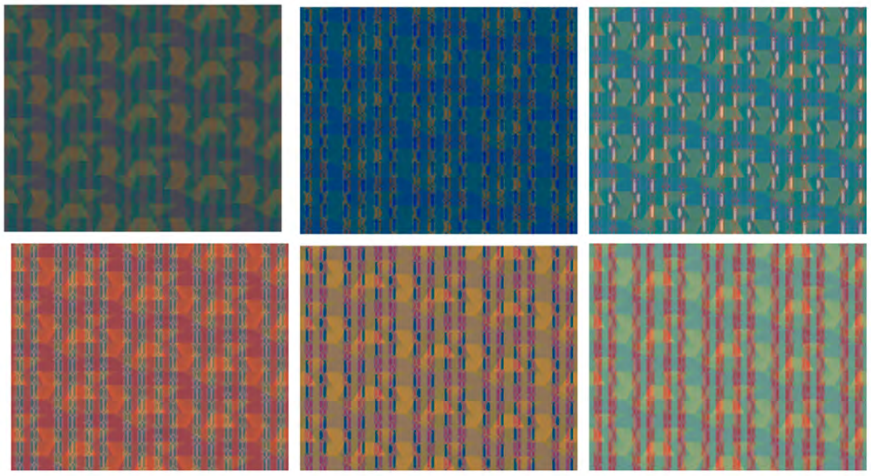
Enid Marx Design work

Marion Dorn Design work

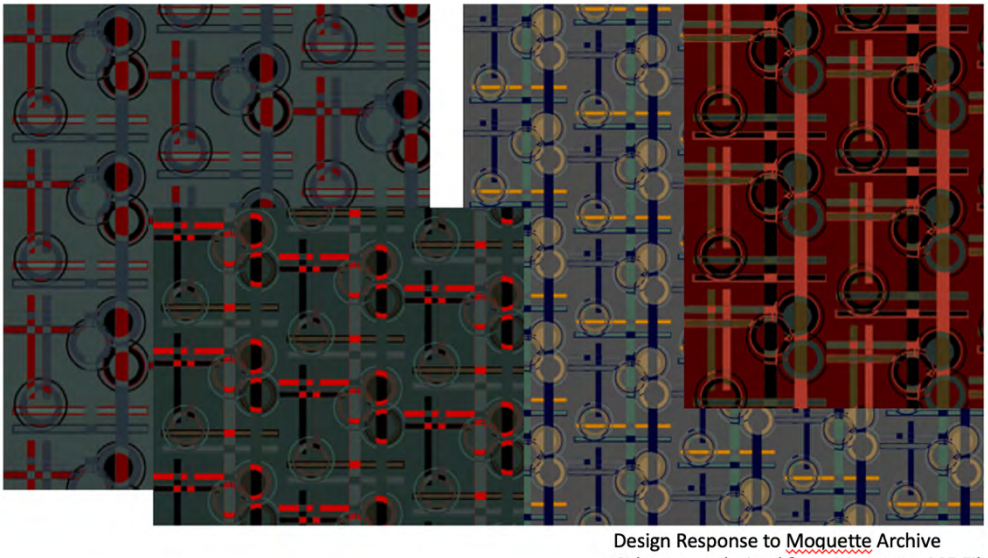
London Passenger Transport Board Moquette Colour Studies



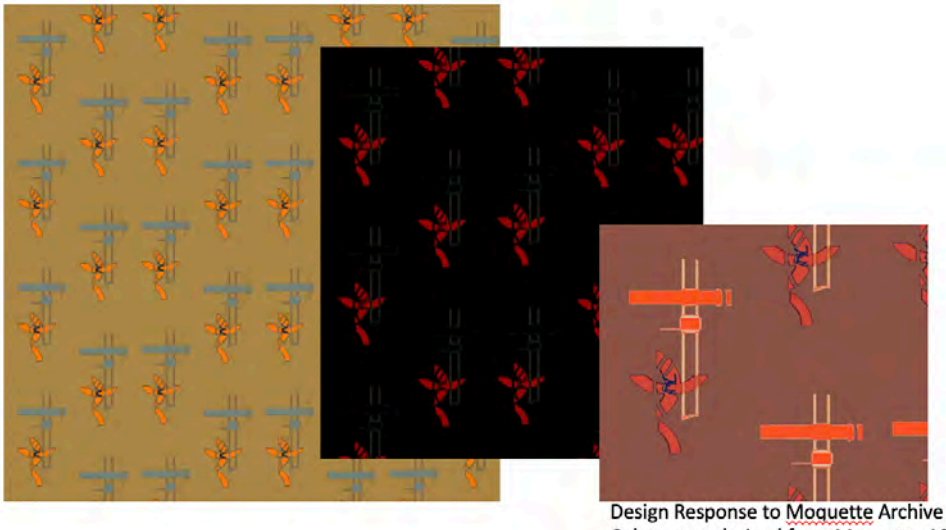
Moquette ASE Colour Swatch File



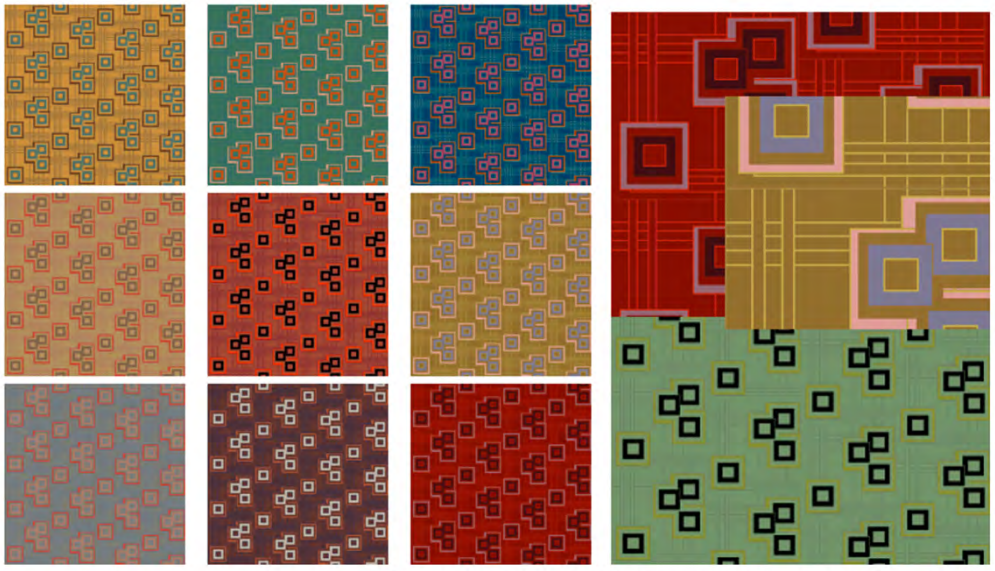
Design Response to Moquette archive
Colourways derived from Pantone ASE Swatch File



Design Response to Moquette Archive
Colourways derived from Moquette ASE File



Design Response to Moquette Archive
Colourways derived from Moquette ASE File
And Anatomy of Colour ASE File



Design Response to Moquette archive. Colourways derived from Pantone ASE File

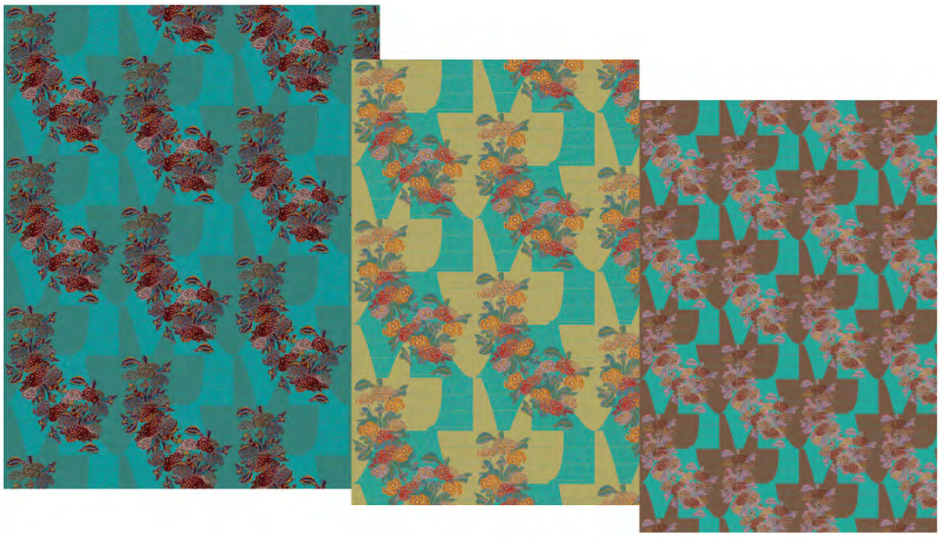
OMEGA WORKSHOP

Omega Workshop Exhibition
Victoria Rooms Bath UK

Design Response to Omega Workshop Exhibition
Colourways derived from Anatomy of Colour ASE File

Design Response to Omega Workshop Exhibition
Colourways Derived from Anatomy of Colour ASE File

COLEFAX & FOWLER



Design response to Colefax and Fowler
Colourways derived from Anatomy of Colour ASE File

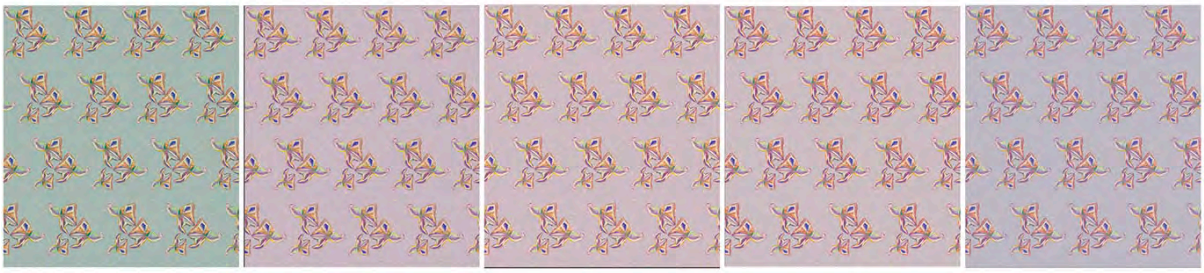
Challenging Colours identified from visual assessment of sample prints

Corresponding swatches in Colour Reference Book assessed to check if good match

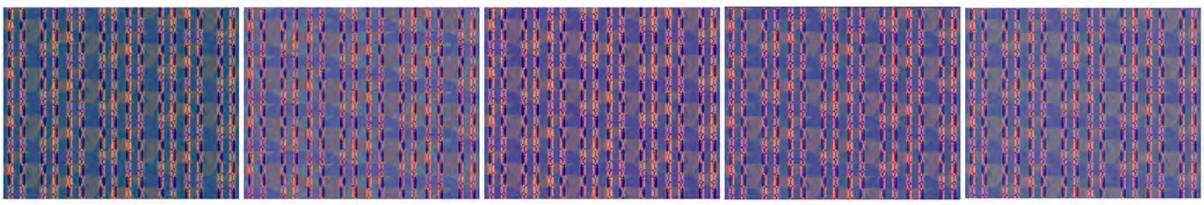
- Poor matches discarded
- Close hues discarded
- Six colours taken forward
- Substrates swatches measured for Digital Lap Dip tests
- Colour Maps created

Substrate indicator profiles applied to artwork

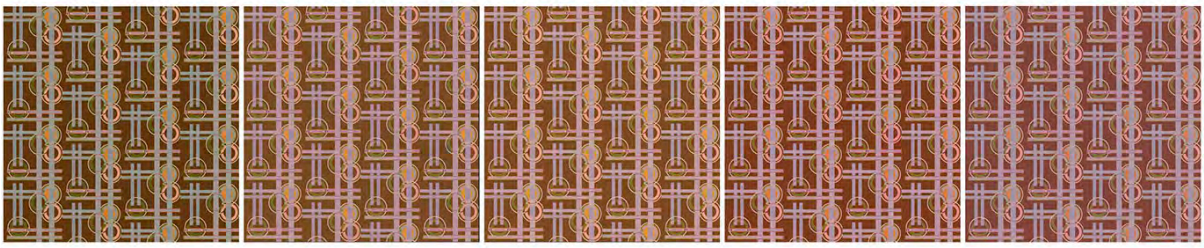
aricular patten 3.jpg aricular patten 3 cotton profile copy.jpgaricular patten 3 linen profile copy.jpg aricular patten 3 silk profile copy.jpg aricular patten 3 wool profile copy.jpg



hunter colourway 4.jpg hunter colourway 4 cotton profile copy.jpghunter colourway 4 linen profile copy.jpghunter colourway 4 silk profile copy.jpghunter colourway 4 wool profile copy.jpg



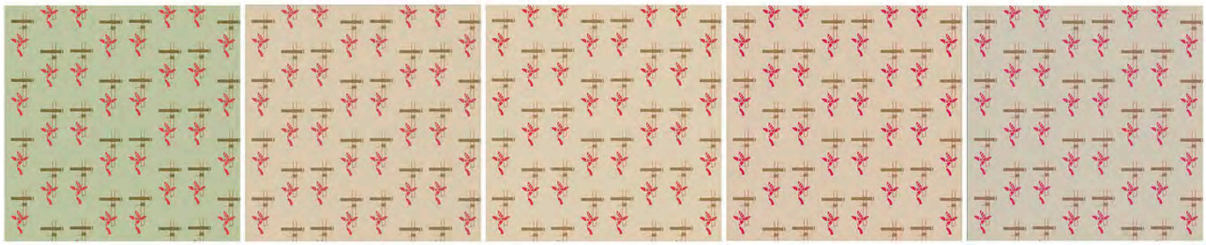
london transport design 1 colourway 1.jpglondon transport design 1 colourway 1 cotton p... london transport design 1 colourway 1 linen pr... london transport design 1 colourway 1 silk prof... london transport design 1 colourway 1 wool pro...



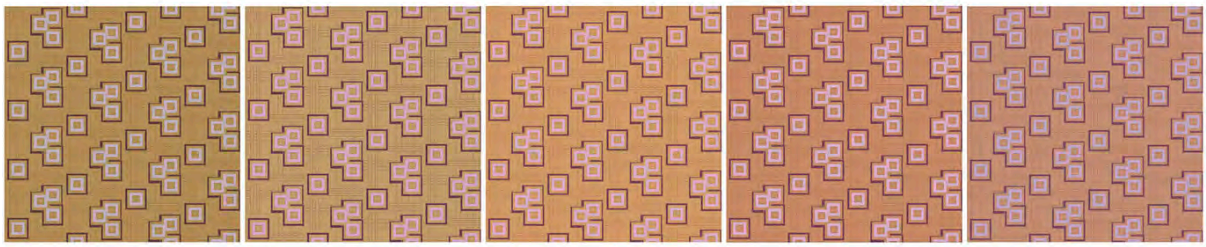
london transport design 2 colourway 5.jpglondon transport design 2 colourway 5 cotton p... london transport design 2 colourway 5 linen pr... london transport design 2 colourway 5 silk prof... london transport design 2 colourway 5 wool pro...

london transport design 2 colourway 12.jpglondon transport design 2 colourway 12 cotton ... london transport design 2 colourway 12 linen p... london transport design 2 colourway 12 silk pro... london transport design 2 colourway 12 wool p...

london transport design 3 colourway 14.jpglondon transport design 3 colourway 14 cotton ... london transport design 3 colourway 14 linen p... london transport design 3 colourway 14 silk pro... london transport design 3 colourway 14 wool p...

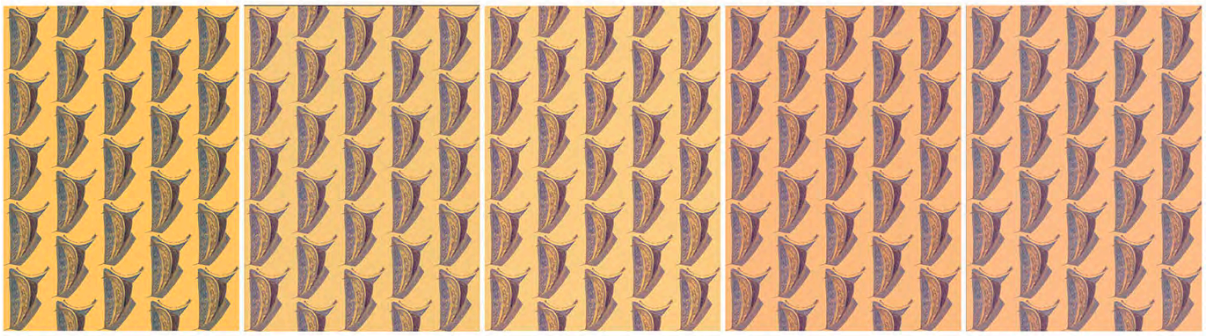


london transport design 3 colourway 15.jpglondon transport design 3 colourway 15 cotton ... london transport design 3 colourway 15 linen p... london transport design 3 colourway 15 silk pro... london transport design 3 colourway 15 wool p...

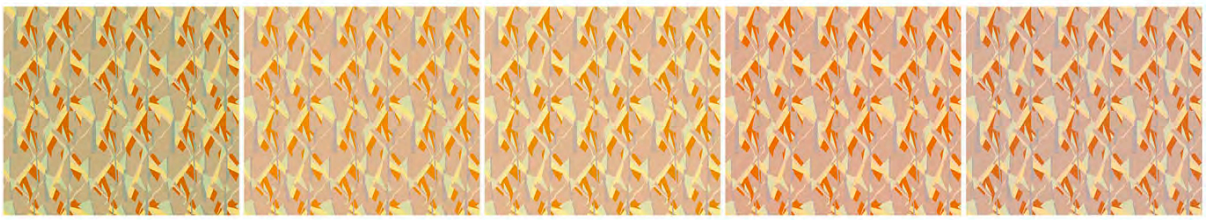


london transport design 4 colourway 13.jpglondon transport design 4 colourway 13 cotton ... london transport design 4 colourway 13 linen p... london transport design 4 colourway 13 silk pro... london transport design 4 colourway 13 wool p...

omega design three colourway 11.jpg omega design three colourway 11 cotton profi... omega design three colourway 11 linen profile... omega design three colourway 11 silk profile ... omega design three colourway 11 wool profile...



omega design two colourway 2.jpg omega design two colourway 2 cotton profile ... omega design two colourway 2 linen profile co... omega design two colourway 2 silk profile cop... omega design two colourway 2 wool profile co...



omega design 1 colourway 24.jpg omega design 1 colourway 24 cotton profile c... omega design 1 colourway 24 linen profile cop... omega design 1 colourway 24 silk profile copy.jpg omega design 1 colourway 24 wool profile cop...

london transport design 2 colourway 7.jpglondon transport design 2 colourway 12 cotton ... london transport design 2 colourway 12 linen p... london transport design 2 colourway 12 silk pro... london transport design 2 colourway 12 wool p...

On screen substrate indicator profiles compared to physical sample prints and visual assessment made to see whether they offer a good indication of how colour outcome changes when print is made on different substrates.

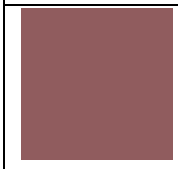
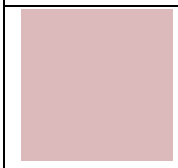
For 9 colours the substrate indicator profiles provided a good indication on screen on colour changes dependent on substrate.

These were 67, 477, 524, 596, 648, 667, 813, 980, & 1068

Scan the QR code to use search for these Pantones on screen.

Pantone Swatch	Pantone Reference	Interwar Case Study Design Reference	In comparison with Colour Reference Book Comments*	Colour Map created? Y/N
	67 Pantone 134 C Solid Uncoated	Number 6 Omega Design 3 Yellow Colourway Pantone 1940 Colour palette Yellow differs on all substrates. Silk Closest match	The yellow swatches print very similarly to the interwar print. This pantone colour is not flagged by APCC as out of gamut. The swatches differ but not greatly. It is only when you see them with the darker design of the interwar print that the difference is exaggerated. The motif is primarily grey, brown.	Y
	477 Pantone 376 U Solid Uncoated	Number 19b London Transport Design Confetti Collectors Green Colourway Parsons BMeyer Peruvian Inca from the Anatomy of Colour palette Linen is closest match Green differs on all substrates	The pantone is an ok match for the screen colour but is not very precise. The green swatches print very differently to the background of the interwar print. This could be due to translation between swatch measurement and conversion to LAB then into APCC and then converted to Pantone not giving best visual match. This	N

			colour is not flagged by APCC as out of gamut	
	524 Pantone 415 U Solid Uncoated	Number 20 London Transport Confetti Collectors Grey Brown Orange Colourway Anatomy of Colour Palette - Parsons French Empire Hyacinth	The pantone colour is a good match for the screen colour. The printed swatches differ greatly to screen colour. They are widely different from each other as well. APCC does not flag this colour as out of gamut. The interwar prints are similar to the printed swatches. The silk is probably the closest match. The difference is more apparent in the swatches than in the printed design where the grey is printed alongside brown and orange.	Y
	596 Pantone 4525 U Solid Uncoated	Number 9 Omega Design 1 Tan / Yellow/ Orange Green colourway Parsons Public pale brown	The printed swatches differ greatly to each other and the screen colour. Linen is pink, wool yellow, silk brown and cotton closest match. This colour is not flagged as out of gamut by APCC. In the interwar prints the cotton is pink the wool	Y

			yellow, the linen brown and the silk the closet match. The pantone colour matches that of the screen colour but is very different to the printed colour	
	648 Pantone 491 U Solid Uncoated	Number 10 Omega Design one Rose / Yellow / Cream / Burgundy Colourway Anatomy of Colour Palette - Parsons B Meyer Persian Fresco Mulberry This colour is not background but a feature of the motif. It differs on all substrates	The swatches are much more purple than the screen colour. The silk is the closest match. The swatches have printed very similarly to the interwar design. They do not look that dissimilar in the swatch book but when placed next to other colours in the design the difference was made more obvious. APCC does not flag this colour as out of gamut	Y
	667 Pantone 5025 U Solid Uncoated	Number 13 London Transport Design Motif Pink Grey Colourway Pantone 1940 Colour Palette	The swatches differ greatly from screen colour and each other. The linen is the closest match. The cotton in particular is much deeper pink. The interwar prints are much more vibrant than the	N

			swatches. The pantone is an ok match for the original colour but is much bluer. Another translation issue. The silk is the palest. Then linen, cotton and darkest wool. This colour is not flagged by APCC as out of gamut.	
	687 Pantone 5155 U Solid Uncoated	Number 7 Omega Design 2 Pale blue pink colour way Pantone 1930 Colour Palette	The pantone is an ok match for the screen colour. The printed swatches differ greatly to each other. This colour is not flagged as out of gamut by APCC. Wool is poorest match and cotton closest. The interwar prints are very different to the swatches. The wool, linen and silk are similar but cotton is much more vibrant in the interwar print than the swatch, yellower and warmer.	Y
	787 Pantone 5665 U Solid Uncoated	Number 1 Hunter Design one Pale Blue Anatomy of Colour Palette - Parsons Wedgwood Pale Blue	The pantone is not a great match for the screen colour. The screen colour is more red rather than this duck egg yellow.	N

			(translation issue). The swatches are similar to the screen colour and to each other. This colour is not flagged by APCC as out of gamut. The interwar prints are different to the pantone.The cotton is darkest followed by the linen and then silk. The wool is more green. The linen is the closet match to the swatches.	
	813 Pantone 5787 U Solid Uncoated	Number 18 London Transport Design Confetti Collectors Rose yellow and green colourway Anatomy of Colour Palette - Parsons Oriental Pale Celadon Green This is not a background colour but a key stripe and circle in the motif	The pantone is an ok match for the screen colour but the screen colour is yellower whereas this seems more grey. The swatches differ greatly from the screen colour and from each other. The cotton is closest match, wool yellower, linen browner and silk warmer. The swatches are very similar to the interwar prints. This colour is not flagged by APCC as out of gamut.	Y

	980 Pantone 7418 U Solid Uncoated	Number 4 Colefax and Fowler Pink and Turquoise colourway Anatomy of Colour Palette - Jennings Flamyl pink	The pantone is not a good match for the screen colour which is paler and bluer. The printed swatches don't seem too different. Cotton is closest match to screen colour. The interwar prints are a very different pink. Another translation conversion I think. (LAB AVA to LAB APCC to Pantone). On closer inspection the linen and wool are similar to the swatches but the cotton is much deeper and bluer as is the silk. This colour is not flagged as out of gamut by APCC	N
	1032 Pantone 7470 U Solid Uncoated	Number 16 London Transport Design Stripes Pantone 1910 Colour Palette	The pantone is not a good match for the screen colour which is yellower. The swatches differ to the interwar prints. Another lost in translation perhaps (convert from LAB in AVA to LAB in APCC to Pantone) The swatches do differ but not obviously so.	N

			Similarly the blues in the interwar design probably appear to be more different because of the placement next to other colours (other shades of blue and orange). This colour is not flagged by APCC as out of gamut.	
	1035 Pantone 7473 U Solid Uncoated	Number 5 Omega Design 3 Beige blue and red colourway Pantone 1940 This colour is in the motif and not the background	The pantone is not a great match for the screen colour which is more of a sky blue and the pantone is greener. The swatches are all very similar except they appear greener than the screen colour and the wool the most green, followed by linen. The cotton is closest match. The blue in the interwar design print seems to be lighter, this pantone translation is more duck egg blue and the interwar blue has more red in it. Another lost in translation. The wool is a faded blue, the silk is	N

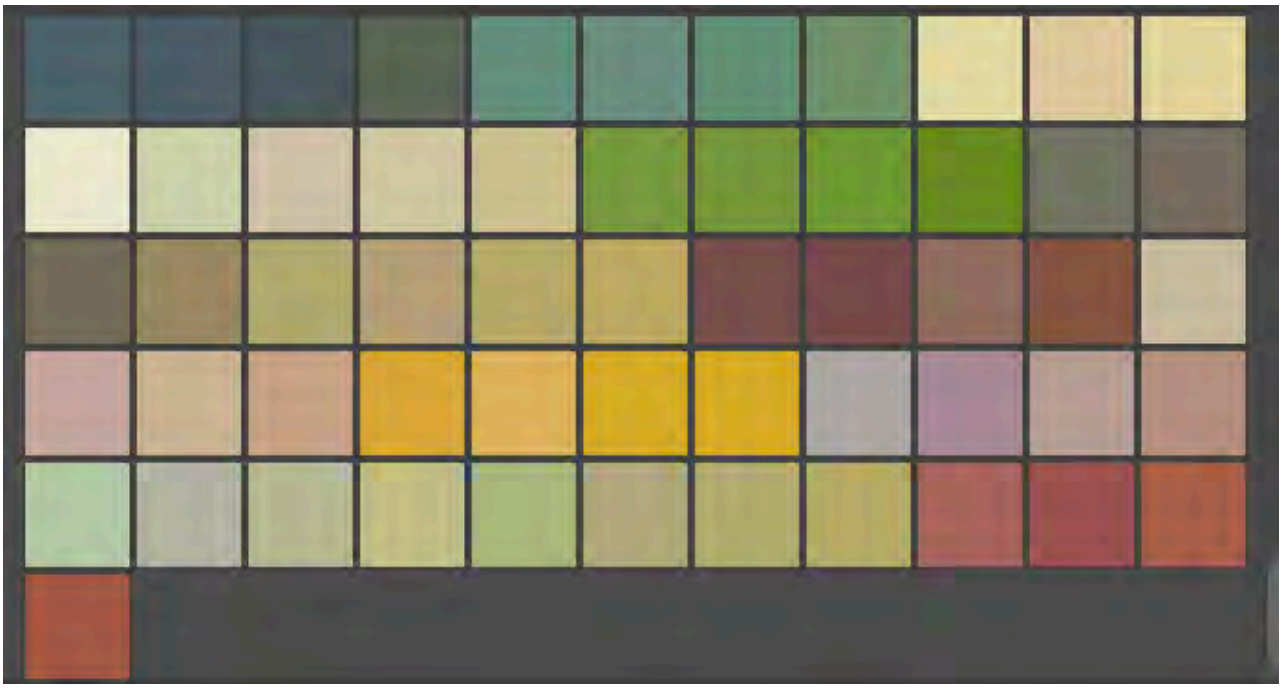
			closest match and the linen and cotton are fairly similar to each other.	
	1068 Pantone 7506 U Solid Uncoated	Number 15 London Transport Square design Pantone 1930 Colour Palette This is not the background colour but a square in the motif	The pantone is not a good match for the screen colour which is greyer. The printed swatches are fairly similar except the linen which is pinker. In the interwar print the linen is the closest match to the screen colour. All of the interwar prints appear pinker than the screen colour. This colour is not flagged by APCC as out of gamut. The interwar prints and the swatches differ and I think this is another translation issue.	N
	1089 Pantone 7527 U Solid Uncoated	Number 5 Omega Design 3 Beige blue and red colourway Pantone 1940 Colour Palette	The pantone is not a good match for the screen colour. The screen colour is more khaki green grey. The pantone is yellow grey. The swatches differ greatly from the screen colour and each other. Silk is	N

			closets match. Wool yellower, linen pinker, cotton cooler and silk greener. The interwar prints differ a lot from the swatches. Another translation issue. Cotton is very dark, silk is closest match, wool and cotton very similar. This colour is not flagged by APCC as out of gamut	

*a translation issue – the colours were identified using visual analysis of the printed fabrics. Then the digital file was analysed in AVA CAD CAM to determine which colour was an issue. The LAB reference was noted and colour palette ase file compiled of the tricker to print colours. AVA notes the LAB reference to 3 decimal points. This was then opened in Adobe Photoshop which uses only whole numbers for LAB references so figures are rounded up or down. This will alter the colour data. The colour picker tool was then used in Adobe Photoshop to convert the LAB swatches to the nearest Pantone library reference for the Solid Uncoated Library. It is here that some of the biggest colour translation differences occur. Where the pantone reference differed from the screen colour and was widely different to the printed colours (swatches) then it was not taken further into a colour map. Where the pantone reference differed from the screen colour but there were similarities with the printed colours (swatches) then a colour map was created. Where the pantone reference, screen colour and the printed swatches seemed to have some correlation then a colour map was created. Where the pantone reference differed from the screen colour AND the printed swatches were very dissimilar then no colour map was created as the researcher felt that it would provide any additional useful information about colour assurance of screen to print colour using the interwar prints.

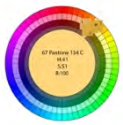
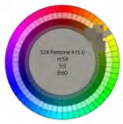
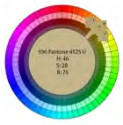
20 of the most problematic colours were identified using visual analysis. These are highlighted in the interwar print swatch book and highlighted with a post it showing numerical reference. The page is then annotated with the ase swatch colour used and the corresponding LAB reference from AVA. When the colours were analysed in AVA it was discovered several challenging colours were actually the same ase swatch colour and so this reduced the number of colours to 18. When the pantone references were identified there were a number of colours which were similar, ie close together in the pantone range, and so discarded reducing the colours to 14. The corresponding swatches in the colour reference book to the pantone reference were subsequently measured using a X-RITE 1 spectrophotometer. The data was recorded using the measuring instrument tool in AVA.

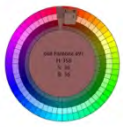
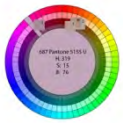
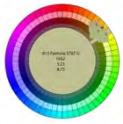
Whilst data was recorded for all 14 colours, translation issues meant that not all were taken forward to the colour maps.



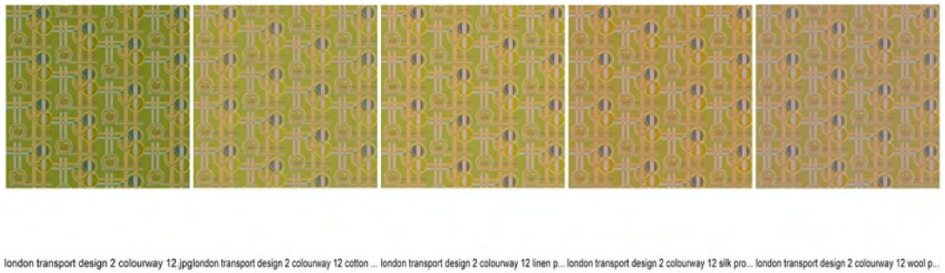
ASE File of the 14 colours measured directly from the colour reference book

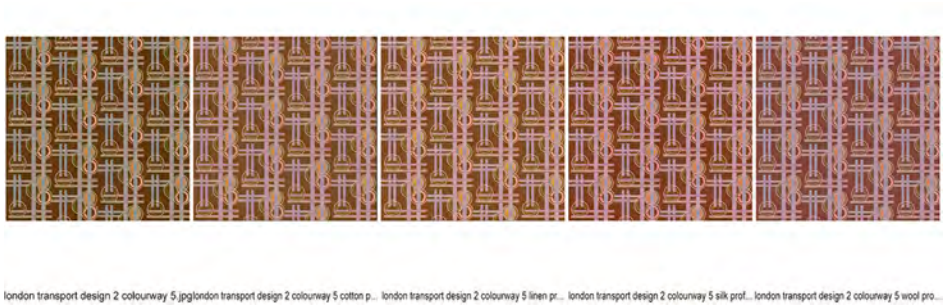
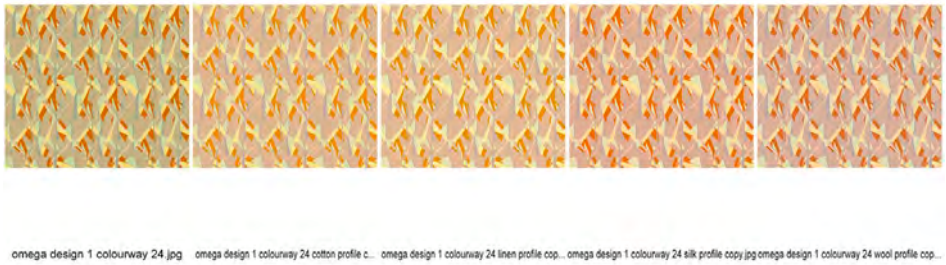
Order
1032 Pantone 7470 C Cotton, Linen, Silk, Wool
1035 Pantone 7473 C Cotton, Linen, Silk, Wool
1068 Pantone 7506 Cotton, Linen, Silk, Wool
1089 Pantone 7527 Cotton, Linen, Silk, Wool
477 Pantone 376 Cotton, Linen, Silk, Wool
524 Pantone 415 Cotton, Linen, Silk, Wool
596 Pantone 4525 Cotton, Linen, Silk Wool
648 Pantone 491 Cotton, Linen, Silk, Wool
667 Pantone 5025 Cotton, Linen, Silk, Wool
67 Pantone 134 Cotton, Linen, Silk, Wool
687 Pantone 5155 Cotton, Linen, Silk, Wool
787 Pantone 5665 Cotton, Linen, Silk, Wool
813 Pantone, 5787 Cotton, Linen, Silk, Wool
980 Pantone 7418 Cotton, Linen, Silk, Wool

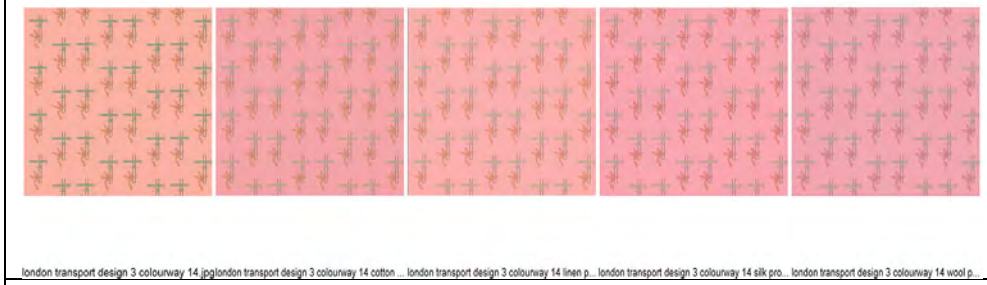
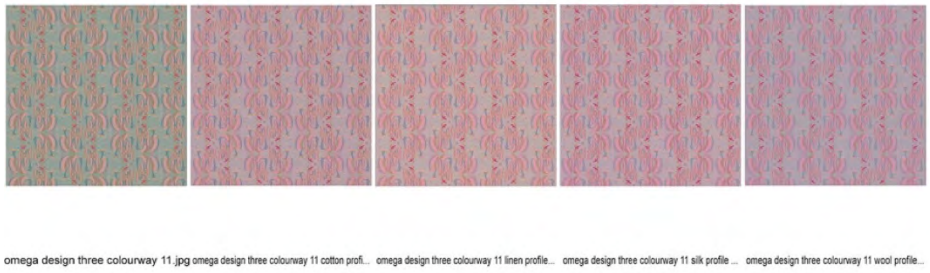
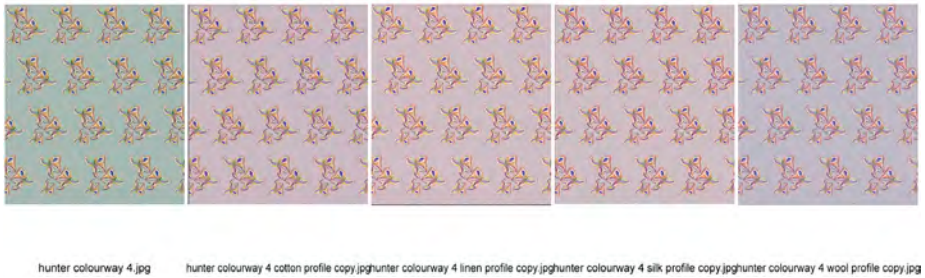
Colour Map 1	Colour Map 2	Reference	Comments	Good indicator?
		67 Pantone 134 C Solid Uncoated	The indicator colour is a darker yellow than the screen colour. It is similar to the interwar prints but they are brighter more saturated. Using this colour map would indicate to a designer that the printed colour would look darker but not give a sense of the acidic-ness of the printed yellow	Y
		524 Pantone 415 U Solid Uncoated	The indicator colour is greener and darker than the screen colour. It bears little similarity to the printed colours. I think the wool throws off the indicator colour because the swatch is quite green in comparison. This colour map would not give a good indication to the designer of how this colour might print on different substrates	N
		596 Pantone 4525 U Solid Uncoated	The indicator colour is darker but similar to the printed colour for three of the substrates (linen, wool and silk) but not the cotton which is pinker. This colour map would therefore give the designer an indication of how this colour might print on	Y

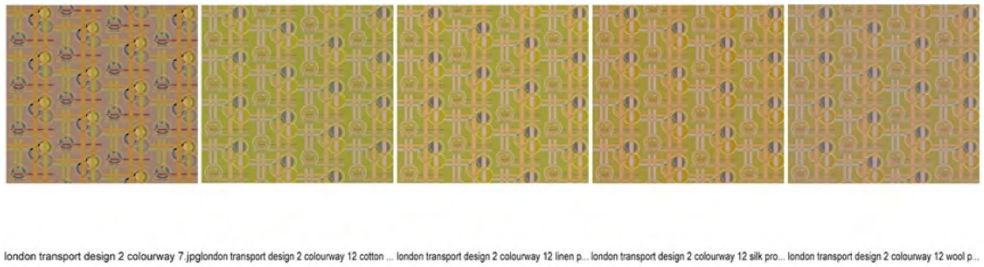
			some substrates but not all.	
		648 Pantone 491 U Solid Uncoated	The indicator colour is an ok match for three of the substrates (linen, wool and silk) but not the cotton which is darker but not a precise match. This colour map would therefore give the designer some indication of how this colour might print but not a very accurate one.	Y
		687 Pantone 5155 U Solid Uncoated	The indicator colour is not a good match for any of the substrates. It is too dark and rather grey and dull in comparison to the prints which are much more vibrant and pinker. The measurements for the swatches are widly different to the screen colour and so this must throw the indicator colour off. In addition the visual analysis of the swatches highlighted that this pantone was a tricky match.	N
		813 Pantone 5787 U Solid Uncoated	The indicator colour is a good match for the printed colour. The swatches measurements are all close together. Visual analysis of the swatches in comparison to the prints showed that they were a good	Y

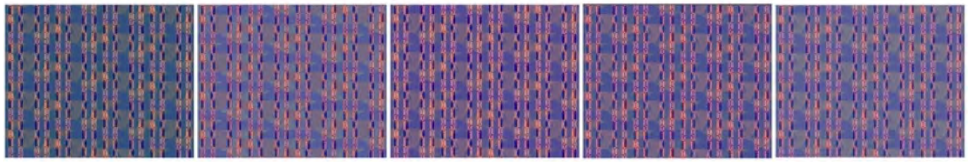
			match also. This colour map would give a designer a good indication of how this colour might print.	

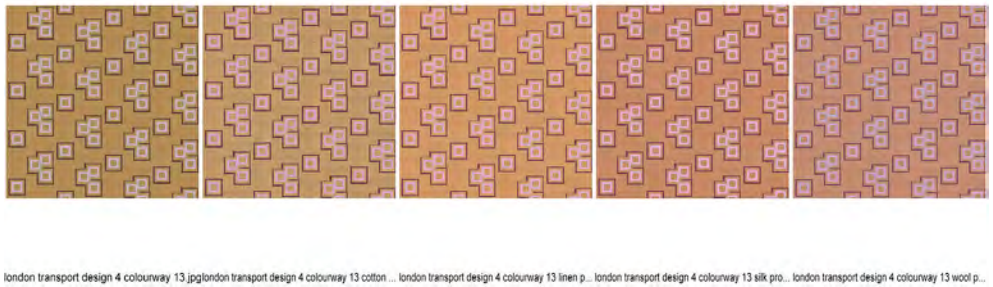
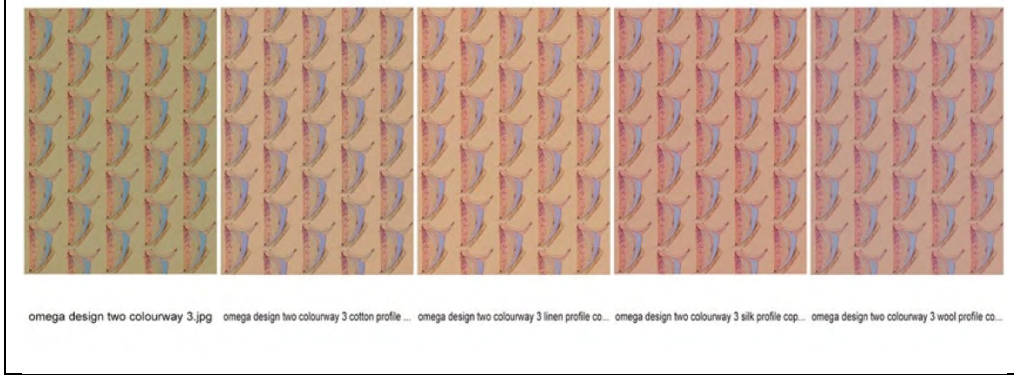
Design (L-R: screen, cotton, linen, silk, wool)	Pantone Reference identified via LAB translation	Comments	Good
omega design two colourway 2.jpg omega design two colourway 2 cotton profile ... omega design two colourway 2 linen profile co... omega design two colourway 2 silk profile cop... omega design two colourway 2 wool profile co...	67 Pantone 134 C Solid Uncoated	The pantone is a good match for the screen colour. The cotton is much pinker and darker than the applied profile suggests. The linen is a good match, the wool is similar but the silk is not as pink. This colour was taken forward for a colour map	Y
 london transport design 2 colourway 12.jpglondon transport design 2 colourway 12 cotton ... london transport design 2 colourway 12 linen p... london transport design 2 colourway 12 silk pro... london transport design 2 colourway 12 wool p...	477 Pantone 376 U Solid Uncoated	The pantone is an ok match for the screen colour but not very precise The applied profiles are very similar to the prints except the linen which is cooler than the applied profile indicates. The silk and cotton are very good matches. The wool is darker and whilst the yellow is similar in tone the background is not. Overall the tonal change is a good indication of how this design will print even if it is not precise.	Y

	524 Pantone 415 U Solid Uncoated 	The pantone is a good match for the screen colour. It looks at the stripe colour not the background. The cotton is not as pink as the applied profile, nor the linen, wool or silk. However the overall tonal change gives an indication of how the colours might print. This colour was taken forward for a colour map	Y
	596 Pantone 4525 U Solid Uncoated 	The pantone is a good match for the screen colour The applied profiles are very similar to the actual prints although not a precise match they give an indication of the colour change. The linen is the least like the print and seems yellower rather than paler. This colour was taken forward for a colour map	Y
	648 Pantone 491 U Solid Uncoated 	The pantone is a good match for the screen colour. The applied profiles are very similar to the actual prints which do become this deeper rosey red rather than orange red. This particular colour was part of the motif rather than the background and appears to match the prints although not precisely.	Y

		This colour was taken forward for a colour map. The linen is yellower in the applied profile than the print. The wool is darker in the print than the applied profile.	
 london transport design 3 colourway 14.jpglondon transport design 3 colourway 14 cotton ... london transport design 3 colourway 14 linen p... london transport design 3 colourway 14 silk pro... london transport design 3 colourway 14 wool p...	667 Pantone 5025 U Solid Uncoated	The pantone is not a good match for the screen colour The applied profiles are incredibly similar to the prints. The change in pink is very similar. The linen is more yellow in the applied profile than in the print. The silk is darker in the applied profile than in the print. The cotton and wool are a very good match.	Y
 omega design three colourway 11.jpg omega design three colourway 11 cotton profi... omega design three colourway 11 linen profile... omega design three colourway 11 silk profile ... omega design three colourway 11 wool profile...	687 Pantone 5155 U Solid Uncoated	The pantone was a good match for the screen colour. The prints are not as pink as the applied profiles suggest but tonally are a good match. The blue background is not correct but the changes to the pink are similar. This colour was taken forward for a colour map	N
 hunter colourway 4.jpg hunter colourway 4 cotton profile copy.jpghunter colourway 4 linen profile copy.jpghunter colourway 4 silk profile copy.jpghunter colourway 4 wool profile copy.jpg	787 Pantone 5665 U Solid Uncoated	The pantone is not a good match for the screen colour Visual analysis of the prints shows that the pinker look of the profiles when applied to the screen image is not apparent in the printed substrate. In fact the printed substrate is greener if anything. The silk is the closest match of print to applied profile.	N

 london transport design 2 colourway 7.jpglondon transport design 2 colourway 12 cotton ... london transport design 2 colourway 12 linen p... london transport design 2 colourway 12 silk pro... london transport design 2 colourway 12 wool p...	813 Pantone 5787 U Solid Uncoated	The pantone is good match for the screen colour The applied profiles are not very similar for the cotton or linen but the silk is similar. The wool is much darker but the tones are quite good. Overall the applied profiles have indicated that the prints will be much greener and lighter than they have come out. The particular green highlighted does change in a similar tonal way to the applied profiles in the prints. This colour was taken forward for a colour map.	Y
 aricular patten 3.jpg aricular patten 3 cotton profile copy.jpgaricular patten 3 linen profile copy.jpg aricular patten 3 silk profile copy.jpg aricular patten 3 wool profile copy.jpg	980 Pantone 7418 U Solid Uncoated	Visual analysis of the prints show a remarkable similarity to the applied profiles in all except the linen which is not as yellow as the applied profile but is indeed paler than the screen design. The cotton is darker, the silk cooler and the wool slightly warmer. The overall 'feel' of the applied profiles is very similar to the prints. However the colours are not exactly the same in particular the turquoise is more vivid in the prints than the applied profiles suggest. A good indication but not very precise.	Y

 london transport design 1 colourway 1.jpglondon transport design 1 colourway 1 cotton p... london transport design 1 colourway 1 linen pr... london transport design 1 colourway 1 silk prof... london transport design 1 colourway 1 wool pro...	1032 Pantone 7470 U Solid Uncoated 	The pantone is not a precise match but has some similarities to the screen colour. The applied profiles have similar tonal changes on the different substrates as the prints but the prints are much darker. Looking at the blue in particular it is much darker in the print than on the screen, more similar to the exact screen design. The tonal differences are slightly similar, for instance the silk and the cotton print are alike, the linen is not as yellow as the applied profile and the wool is much more green in tone than the applied profile indicates.	N
 omega design two colourway 3.jpg omega design two colourway 3 cotton profile ... omega design two colourway 3 linen profile co... omega design two colourway 3 silk profile cop... omega design two colourway 3 wool profile co...	1035 Pantone 7473 U Solid Uncoated 	The pantone colour is a poor match for the actual colour used. The overall look of the applied profile is not the correct colour match for the prints particularly the background colour but looking at the blue which is the one highlighted here it can be observed that the blues in the applied profiles are lighter than those of the prints but the tonal differences between the substrates in the applied profiles and the prints are very similar.	N

 london transport design 4 colourway 13.jpglondon transport design 4 colourway 13 cotton ... london transport design 4 colourway 13 linen p... london transport design 4 colourway 13 silk pro... london transport design 4 colourway 13 wool p...	1068 Pantone 7506 U Solid Uncoated	The pantone is a good match for the screen colour The overall look of the applied profiles is similar but not a precise match to the prints. For instance the cotton print is much darker than the applied profile. But the colour change, becoming more purple, is similar. The linen is not as yellow but the purple tint is similar. The wool is not as warm but the purple tint is similar. The silk is not as dark as the applied profile but is a good tonal match.	Y
 omega design two colourway 3.jpg omega design two colourway 3 cotton profile ... omega design two colourway 3 linen profile co... omega design two colourway 3 silk profile cop... omega design two colourway 3 wool profile co...	1089 Pantone 7527 U Solid Uncoated	The pantone colour is a poor match for the actual colour used. The applied profiles suggest a much pinker look to the actual prints. However the differences between the substrates is of a similar effect tonally even if the colour range is not a good match. The linen is lighter, the wool warmer etc. However the colour range is not a good match to the prints	N

Appendix H
Data analysis of Colour Reference Book

This appendix presents the data analysis that was undertaken as part of the assessment of the Colour Reference Book

It features a set of work relating to a number of propositions around what might make a colour be tagged as out-of-gamut.

Data analysis was conducted on the numeric values to establish whether any patterns emerged which might indicate whether a colour would be out of gamut. The hypothesis being that high values of red in the RGB data, and brightness in the HSB data, would indicate that a colour would be out of a generic CMYK gamut. This hypothesis was based on the researcher's experience with digital printing. A series of questions were devised and the data analysed using code scripted by Dr Paul O'Dowd.

Examples of the questions asked are as follows:

- If the colour is out of gamut (column g = n) then is the R (column B) >= (greater than or equal to) 150 – (answer Y/N and show value
- If the colour is out of gamut what is the C value (column E)
- When a colour is out of gamut (column g = n) and it is mapped what is the difference between the original R value (column B) and the mapped R value (column B) and does it decrease or increase in value (result would be negative value if it has increased)
- When a colour is out of gamut (column g = n) and it is mapped what is the difference between the original S value (column C) and the mapped S value (column C) and does it decrease or increase in value (result would be negative value if it has increased)
- If a colour is out of gamut what is the H value (column C)

The results returned were unclear. Whilst they established that high values implied that a colour was more likely to be out of gamut, the parameters were too wide for this to be shown clearly, and the questions only applied to out of gamut or in gamut colours, rather than a comparison. Dr O'Dowd converted the results into histograms which unmistakeably demonstrated that high red values indicated that a colour would be out of gamut (figure 15) with 45% of out of gamut colours having a red value of 229 or above.

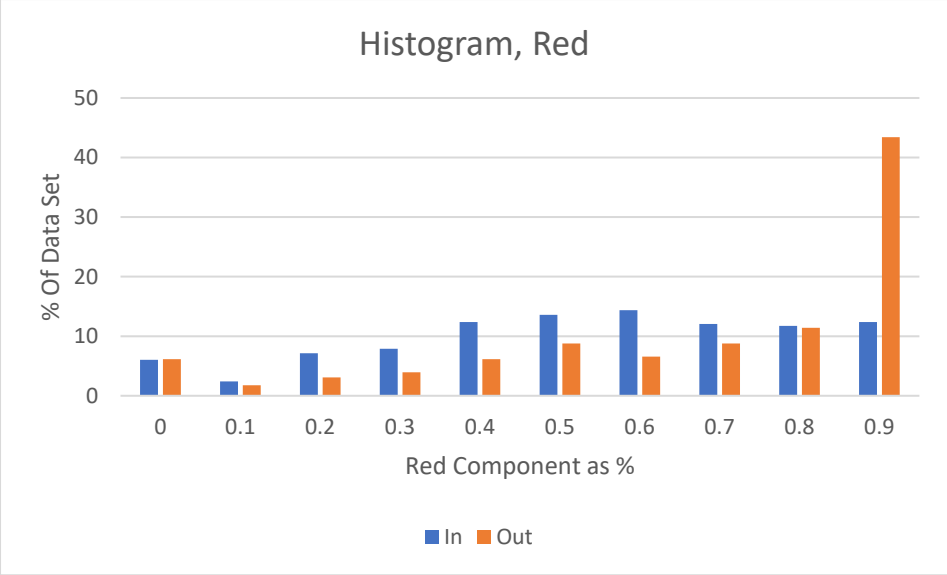


Figure 1 Histogram comparing the set of data for colours in gamut (blue) and colours out of gamut (orange) and the proportion of red in their RGB value. The maximum amount of red is 255 and the minimum is 0. To make a comparison between sets the data was converted into percentages as the in gamut set was significantly larger than the out of gamut set.

In comparison the chart showed a fairly even distribution of colours out of gamut and in gamut for green values (figure 16) and similarly blue (Figure 13). A small spike of hues with a G value between 76-102 are shown as more likely to be in gamut but not significantly so. Of the blue values a similar spike is seen in the range 76-128 making it more likely that a colour is in gamut, but again not significantly so. A low value of blue, 0-25, or a high value,178-204, indicates that a colour might be out of gamut, in comparison to hues with the same blue values that are in gamut, but again, not significantly so.

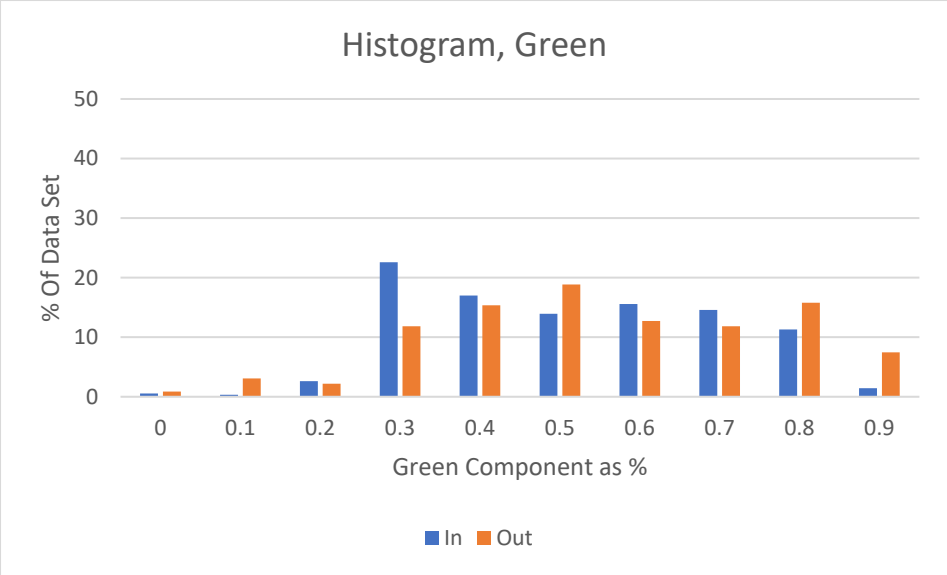


Figure 2 Histogram comparing the set of data for colours in gamut (blue) and colours out of gamut (orange) and the proportion of green in their RGB value. The maximum amount of green is 255 and the minimum is 0. To make a comparison

between sets the data was converted into percentages as the in gamut set was significantly larger than the out of gamut set.

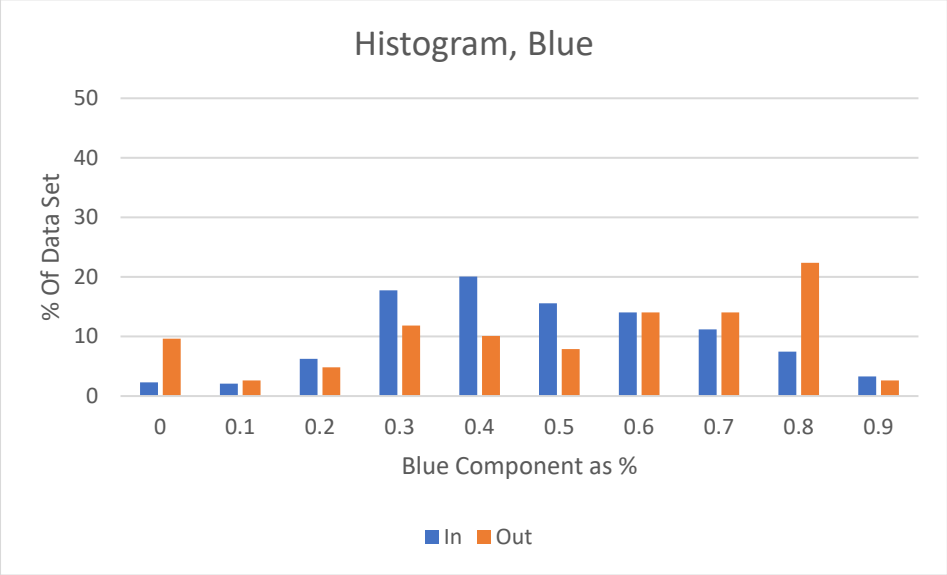


Figure 3 Histogram comparing the set of data for colours in gamut (blue) and colours out of gamut (orange) and the proportion of blue in their RGB value. The maximum amount of blue is 255 and the minimum is 0. To make a comparison between sets the data was converted into percentages as the in gamut set was significantly larger than the out of gamut set.

The HSB values were also plotted as histograms. In Figure 16, the chart clearly shows that hues with an 80% brightness value and above were proportionately likely to be out of gamut. The histogram in Figure 17 implies that a hue with a low saturation value, will be more likely to be in gamut but not significantly so. There is a slight spike where a hue's saturation ranges between 40-60% or 90% and greater that implies it will be out of gamut but again not significantly so.

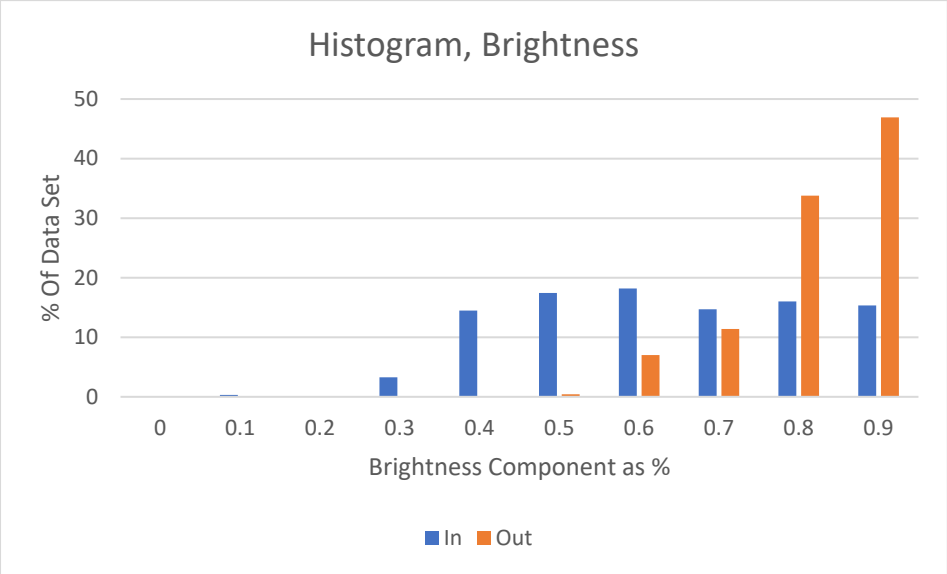


Figure 4 Histogram comparing the set of data for colours in gamut (blue) and colours out of gamut (orange) and the changes in brightness value. Brightness is measured as a percentage.

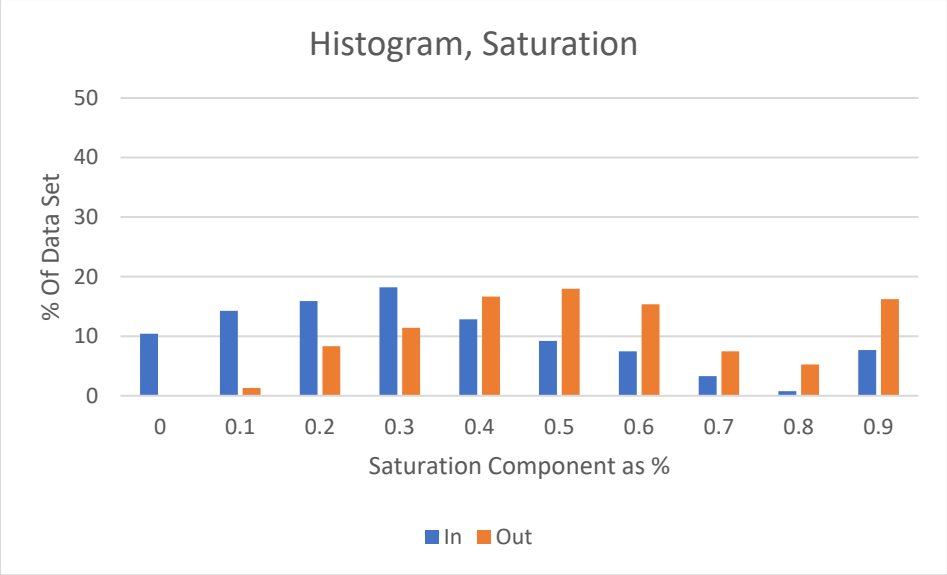


Figure 5 Histogram comparing the set of data for colours in gamut (blue) and colours out of gamut (orange) and the changes in saturation value. Saturation is measured as a percentage.

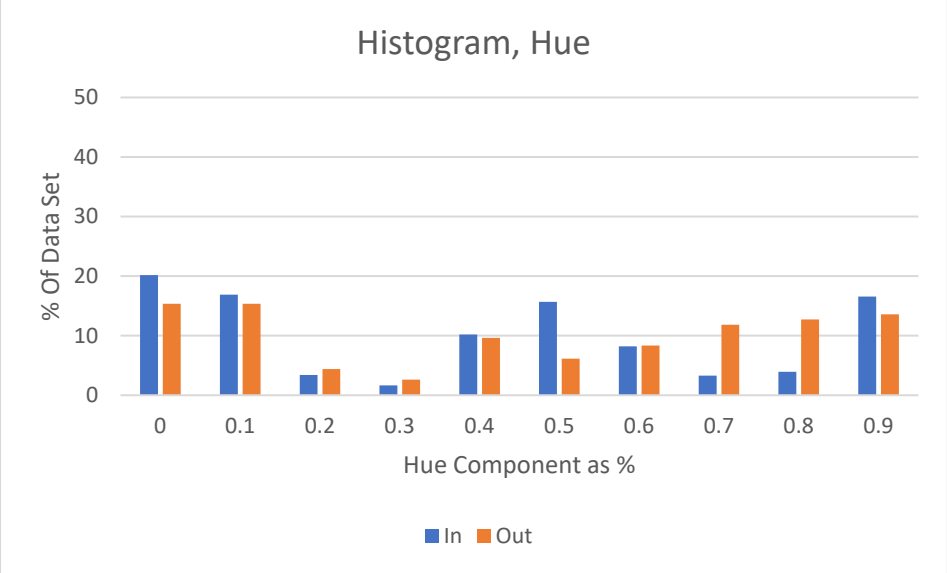


Figure 6 Histogram comparing the set of data for colours in gamut (blue) and colours out of gamut (orange) and the changes in hue value. Hue is measured in degrees and the corresponding colours as follows: red (0°/360° degrees), yellow (60°), green (120°), cyan (180°), blue (240°) and magenta (300°) but has been converted into percentages to make a comparison.

The chart in Figure 18 shows that hues with a value of 252-288, blue to magenta tones, are more likely to be out of gamut and that hues with a value around 180, cyan, will be more likely to be in gamut.

Proving the hypothesis that high red RGB values and significantly bright colours are out of a generic CMYK gamut, thus unprintable, indicates that designers may wish to avoid using overly bright or saturated red colours in design work intending to be digitally printed, if they wish to achieve colour fidelity. However visual observations of the printed colour show that there may be greater disparity in achromatic and neutral colour ranges which are not flagged as out of gamut. The research needs to consider therefore whether this set of out of gamut colours are significantly different enough when printed that they will detrimentally

affect the aesthetics of a printed design and should be avoided, or if improvements in colour management processes made by Raster Image Processors and broader ink bank, negate this issue.