Introduction

Let me introduce myself, in order to give you some context for this paper and rationale as to why I am proposing this hypothesis. The talk will compose of two halves the first in essence is a history lesson on how printmaking relates to industrial printing. I will then use the second half of my talk to explain the development of the Centre for Fine Print Research and how I have reached the position of being able to explain both the historic context of print process and how new technological developments will be very much part of printmaking’s future.

I am a printmaker and have been a printmaker since I made my first lino cut at the age of twelve and my first screen print at the age of fifteen. However I have no clear idea why I became a printmaker and why I am so passionate about the subject, I just am. Having reached the age of sixty-two, I can happily say I am both an artist and an academic. I have spent the last twenty-three years at the interface between art and industry, creating and running a large academic research centre, exploring all aspects of print from a practitioner perspective, which is relevant to both art and industry.

At the Centre for Fine Print Research our projects range from exploring Nineteenth Century Photomechanical print processes and their relevance, to current digital technology, through 3D printed Ceramics to programming robots to make autographic non-digital marks. One of our current concerns is alternative technological
approaches to the half-tone dot through a process we call 2.5D printing. Where an XYZ digital platform is used to paint a photographic image that has been separated by random generation of vector paths rather than a pixel. The centre currently employs, artists, designers, engineers and programmers, but we have always worked with big name English and American artists and craftspeople, such as Richard Hamilton, Peter Blake, Lesley Dill and the ceramicists Richard Slee and Peter Ting. It is from this standpoint that I will develop the following argument.

Printmaking’s History in relation to industry Slide 4

Printmaking has always been inextricably linked to former industrial print processes and the common assumption has been that there are four primary processes that make up the canon of printmaking. Relief Printing, Intaglio printing, Lithography and finally screen printing. Everything else such as wood engraving or lino cuts are seen as a sub-set of the primary process, in this case relief printing. However, I am not sure this holds true any longer, so first lets look at the four basic processes and where their industrial descendants are now placed.

Slide 5

Historically, relief printing is the oldest process and inextricably linked to letterpress, being the first common industrial process in the 15th Century with the advent of book production.

Slide 6

In the twenty first century, however, the primary relief printing process industrially is flexography, a photo-polymeric plate that prints most packaging we use and dispose of, everything from shampoo bottles, cans, milk cartons and the box that your new washing machine arrives packed in.
Cannon ball press Performance in Estonia

The next arrival in our short history lesson, intaglio printing commercially was a part of book production,

but also morphed into printing ceramics from the late seventeen hundreds through the underglaze tissue process.

With the invention of photography and photogravure by Fox Talbot et.al in the mid-nineteenth century, intaglio printing industrially became rotogravure, a process that prints everything from chocolate bar wrappers such as Twix or Hersheys wrappers to postage stamps.

Peter Moseley Intaglio Photopolymer or Flexographic plate

The 18th Century arrival of lithography, created a means of combining type and image for everything from packaging to posters. By the Twentieth Century commercially lithography was ideally suitable for the half-tone process, being able to take a dot and print it accurately, thus enabling photo-lithography.

However whilst lithography was ubiquitous in the later part of the 20th Century, usurping letterpress in the newspaper and book industries, commanding 41% of all printing. It is now under threat from both ink jet and electrostatic printing such as Indigo.
Read Slowly

Jake and Dinos Chapman lithographed poster

Slide 16

Finally even the Twentieth Century process of screen printing started life printing banners and point of sale advertising,

Slide 17

in the early 20th Century and with the advent of inkjet has now become an industrial process that prints everything from car windscreens, kettle elements, diabetes sensors and CD’s.

Slide 18

Stephen Hoskins Left Wing

To put the above in some sort of sense, the UK is the 5th largest producer of printed products with a turnover of over 15 billion Euros and employs 130,000 people. In comparison the UK is the second largest art market in the world with sales of both Art and Antiques of 10 Billion Euros in 2016 and employs 41,700 people. The USA, UK and China between them account for 81 percent of all art sales worldwide.

I hope here that I have moved you a way from the immediate view of printmaking in isolation as an artists medium and firmly placed in your minds the broader context and heritage of the discipline. Art historians and writers of printmaking’s history have tended to concentrate on the artist themselves and less on the process, when they do write about process it either tends to be in relation to social context or about the artwork itself. Very little criticism places the work in its position in relation to technological developments. I want you to take an overview of printing for artists in order to understand why it has undertaken a natural expansion and why I think that is a good thing. Before we get to that overview, I want to demonstrate to you with an example of how changes to industrial print process, have
a direct effect upon the way artists use the process and how those changes can create a whole new approach to art history.

An example of industrial process change that directly affects printmaking. Slide 19

Let us take an example of how industrial change is inextricably linked with printmaking, here we will use screen printing.

I won’t deal with the actual history beginning of screen printing, apart from saying that its true extant origins have been traced to the USA at the turn of the Twentieth Century, the best documented history can be found in Bruno Lengwilers A History of Screen Printing, this excellent volume stops about Nineteen Forty, I want to deal with industrial change to the process that occurred in the early Nineteen Sixties which had a huge influence on the art market, but we do need a little of the earlier history for me to make my point.

Slide 29

Most of us understand that technically at the start screen printing consisted of a silk organza mesh stretched onto a wooden frame with paint forced through a hand cut paper stencil with a squeegee. From the 1920’s to the 1950/60’s, industrial technical developments were small and incremental.

Slide 21

Starting with the screen mesh and the screen frames, until the late 1950’s, silk organza was used, which shrank when wet and being a natural fibre had a consistent thread count, but a variable diameter, each thread being made of multiple twisted fibres which held ink and encouraged staining of the mesh.
This fact combined with wooden screen frames, which tended to warp when wet, made accurate registration a problem. The silk was specifically manufactured for the flour industry, as they used a specific mesh count for sifting flour. The problem with silk is that as a natural fibre it has what might be a hairy surface when viewed under the microscope so attract ink staining and it also expands when wet. Both factors do not contribute to accuracy.

For this period of the 20’s to the 50’s ink for screen printing bore very close relation to gloss paints used for external signage and general use. They were thick films based upon linseed oil mediums, had very slow drying times and tended to be washed up and cleaned with white spirit or turpentine, the traditional solvent for the sign painting industry. In fact in many cases they were almost interchangeable with sign writing products and were called paint, as often as ink. Later in this period saw the introduction of cellulose lacquer based inks that dried in the screen very quickly and were difficult to handle.

In tandem the stencils were of two types a hand cut duplex type, which had a paper backing and a shellac based film layer, which was cut by hand with a knife, taking care not to cut through the backing layer. Commonly called Profilm, this shellac based stencil was adhered to the screen by first laying the stencil under the mesh then attaching it with a damp chamois dipped in a mixture of equal parts of methylated spirits. Finally the stencil was then ironed into the mesh once the mixture had softened the shellac. Whilst more accurate than what came before if the paper backing was cut through the stencil would not adhere properly to the screen.

Previously the screen has been painted directly with a greasy tusche, very similar to a lithographic tusche and then the screen was coated with a screen filler that was water based. The tusche was washed out with white spirit and the screen was printed with oil based colour.
This print by the British artist John Minton is a very good example of how you can see the positive brush marks of the tusche in the dark blue colouring and the pink background is a hand cut stencil either in Profilm, Stenplex green the UK version of Profilm or possibly in a paper cut stencil.

If one required a photographic image then the stencil used was bi-chromated gelatine on a paper backing used in the photogravure industry. In all of my history as an academic, my life has been dominated by bi-chromated gelatine which was essential to every Victorian print process that required a photographic image, whether Collotype, Woodburytype Photo-gravure and in this case screen printing (of which more later). These photo stencils were known as carbon tissue and required not only great skill to expose and wash out, but also to apply to the screen. In the UK Autotype’s carbon tissue was used, a descendent from Joseph Swann’s original gravure tissue. This appears to have been applied wet, straight after exposure and development, I have yet to clarify whether it was first transferred to an acetate foil support or transferred directly to the screen, either way when the tissue was applied to the screen it was adhered by rolling the softish gelatine into the mesh.

So far so good and screen printing had entered the canon of print processes, but remember I am particularly interested in screen printings boom in the Nineteen Sixties to seventies. This image is to demonstrate that things had changed little from the 30’s to the late 50’s. However changes bought about by the popular explosion of photography in the nineteen sixties, heralded a change in the screen print industry. Reprographic line films became readily available along with cheaper copy and process cameras. There was also a fundamental change, from bi-chromated gelatine to the use of iron salts and gelatine coatings on polyester or acetate film backing, which created a more stable support for the stencil.

Slide 24
The classic example of this was Five Star first produced in 1962 by the Autotype Company based in Ealing. Who as we have said were also the primary manufacturers of carbon tissue for rotogravure and had a very distinguished history in the production of bi-chromated gelatine. By the early 70’s photo polymeric SBS emulsions such as Dirasol and films like Cappilex were beginning to gain a footing. All of these changes meant an accurate half-tone could be applied to the screen with far less problems of an interference effect or Moire. In parallel thin film inks based upon heavier solvents and EHEC (Ethyl Hydroxy Ethyl Cellulose) started to be introduced in the very early 1960’s. These inks allowed a very thin matt film to be printed that dried quickly on paper but was slower to dry in the screen. These inks gave the image a clean crisp look and allowed for transparent layers to be printed without a cloudy, yellowish appearance, which the thicker film mediums created. Vinyl, plastic and epoxy based inks were also introduced at this time.

The 1960’s also saw the introduction of the first nylon and monofilament polyester meshes produced on shutterless looms with a consistent thread diameter made by such companies as the Swiss firm Saati. These meshes combined with steel or aluminium frames meant that a constant tension could be applied to the mesh and accurate registration became the norm. It also meant with a consistent thread diameter that it was possible to apply a half-tone stencil to the screen at a consistent angle and there would be no variations in the mesh diameter to cause local moire on the screen. This is not to say it was impossible to apply a half-tone before these changes, but that it was now possible to apply a much finer half-tone consistently with far less problems.

All of these technical developments together produced a completely different sort of imagery, with brighter colour, thinner printed surface and a smooth matt surface, all of which has been documented as
Pop Art seen here by images by Gillian Ayres and Patrick Cauldfield, but without those technical changes these prints would not have existed.

Social historically it would probably be claimed by art historians, that the prints were entirely dependent on the artists and the society around them, but I would argue that the artists were entirely dependent on the technical capabilities of the process. There is no doubt that these images are radical departure to what has gone before. I am not going to labour the point any more, I am sure you have grasped from the slides how the imagery undertook a radical visual shift and I could show you many more examples of how industry influenced printmaking.

Why then is this relevant to the printmaker today? Partly, because I want you to understand that the decisions we make, are influenced by many, many, different factors and approaches. The history we are taught by art theorists is often more to do with their own view of the world and less to do with the path taken by the artist and the pragmatic choices he has made on the way. I also want to highlight some of the preconceptions that tend to come with printmaking taught in arts schools and universities, which then becomes the mantra for a range of practitioners who believe: That printmaking is either a traditional craft skill that should be practiced in one way only, and nothing new should darken the door of the tradition. Or, that the concept is paramount and no skill is necessary and technical mastery of the subject would only darken the purity of that Immaculate Conception. There is a third school that believes the future is digital and that anything to do with printmaking should be thrown out to make way for digital technology and new media.
(Fortunately, we seem to have been moving away from this last view, in the past few years)

I personally believe there is good and bad in all of these views and that the future is a mix of all three, plus an open attitude to both the history of where our technology came from and the future that those technologies might hold. All of which can be summarised as encompassing the craft of the digital, which actually means looking at processes from the perspective of the user, in this case the artist printmaker. I have been a firm advocate of new technologies becoming an integral part of the canon of Printmaking. Inkjet, laser cutting, CNC milling and 3D printing and now robotics, all of which, in my view have, or will become part of the toolkit used by printmakers. Contrary to popular opinion artists are not the quickest adopters of new technology, often waiting until redundant machinery can be repurposed for their own ends. This works for two reasons, firstly because the cost drops dramatically as new technologies become mainstream and secondly because much of the operating knowledge has become accepted practice, thus enabling the artist adopter to quickly gain an understanding of the process. Artists are well aware that the best work always comes when the image transcends the process used to create it. This happens through a fundamental understanding of how that image relates to its material creation, if you are struggling to learn a new process then the chances are you will not create great work.

I want to stress here what I am attempting to say: you cannot make a good print without understanding the process of printmaking. Some artists get round this by collaborating with a professional studio. Most printmakers learn the craft for themselves and strive to gain mastery of one of the processes. This does lead to the eternal dichotomy of the printmaker, that by learning process it is possible to become enamoured with that process for itself and forget why you are learning the medium in order to convey an idea. When the idea is conveyed with such mastery that the process becomes the vehicle to best convey the idea allowing the viewer complete
understanding of the artist’s intention. This is the point at which good printmaking becomes great printmaking.

Tacit Knowledge Slide 29

The one aspect that is common across this whole field for the printmaker is tacit knowledge. The understanding of process and knowledge, passed from one person to the next through the physical action of making, plus the individuals experiential learning. I firmly believe that whether the process is wood engraving or 3D printing a high degree of material understanding and craft knowledge are essential to making great prints, whether individually or collaboratively through a studio.

Whatever anybody says the future is never going to be fully digital, until Artificial intelligence takes over, as humans we have to live, eat and function in a material world. If you look around almost any room in any house at least 95% of what you see is physical and solid. This is not to say that much that is seen as physical and material has not gone through a digital process at some time in its life. Even in this room, the seating for the chairs was probably digitally routed to create the moulds, the cup you are drinking from was probably modelled in CAD and the wallpaper was probably captured digitally before it was printed.

But in a material context we can assume that in real terms everything is analogue in and analogue out, and it is an understanding of the behaviour of materials that are crucial to their manufacture. I will give you several examples from other disciplines to demonstrate what I am trying to say.

To quote Thomas Edison’s familiar words: None of my inventions come by accident. I see a worthwhile need to be met and I make trial after trial until it comes. What it boils down to is one per cent inspiration and ninety-nine per cent perspiration. This is echoed by Richard Sennet in his book ‘the craftsman’ he emphasises the importance of dedicated practice.
'All craftsmanship is founded on skill developed to a high degree. By one commonly used measure, espoused by Malcolm Gladwell, about ten thousand hours of deliberate practice are required to produce a master carpenter or musician. Various studies show that as skill progresses, it becomes more problem attuned, whereas people with primitive levels of skill struggle more exclusively on getting things to work.'

My next example comes from the invention of the airplane, on Dec. 8, 1903 nine days before the Wright brothers first flight, with government funding, countless advisors and great ceremony, the scientist and would be aeronautical engineer Samuel Pierpont Langley’s flying machine plunged into the Potomac.

Nine days later, two bicycle mechanics Orville and Wilbur Wright got their Flyer off the ground.

Why did these bicycle mechanics succeed when a famous scientist failed? Langley’s plans were mostly theoretical and his machine was produced from blueprint and built by others. But by studying the Wright brothers’ working notes, you can see that their insight and their execution are woven together. By trial and error and over a period of time they solved problems like wing shape and wing warping.

‘Having set out with absolute faith in the scientific data, we were driven to doubt one thing after another, till finally after two years of
experimentation, we cast it all aside, and decided to rely entirely upon our own investigations.’

Each adjustment was a small spark of insight that led to others.

**Slide 33**

Finally the idea of tacit knowledge is perhaps best captured by George Sturt in his famous text *The Wheelwrights Shop* which documents the period between 1884 and 1891 when farm carts were still wholly made by hand, just before the general acceptance of machinery into the trade.

This wonderful book makes the argument for an understanding of materials in order to make the best quality artefacts. Sturt’s employees had a complete and tacit knowledge of all of the elements that went into growing, harvesting and seasoning the locally sourced timber they used. They understood implicitly, that in order to make the right shape and strength of shaft, they needed to use timber from the left hand side of the hill, as those trees were affected by the prevailing wind and sunlight, to grow in just the right shape for a shaft. Other trees had similar useful attributes for different parts of the cart.

**Slide 34**

The coming of mechanisation took away all of this tacit understanding and local knowledge and Sturt felt that technology was not a good thing as it took away that inherent knowledge gained over centuries and passed from one worker to the next. He says.

‘But eventually – probably in 1889 – I set up machinery: a gas engine, with saws, lathe, drill and grindstone. And this device, if it saved the situation, was (as was long afterwards plain) the beginning of the end of the old style of business, though it did

**Read Slowly**
Read Slowly

just bridge over the transition to the motor-trade of the present time.’

Slide 35

However what is interesting here is that all of the machinery Sturt describes is a vital part of the modern craftsperson’s toolkit. In fact, many craft woodworkers making furniture today – in addition to being completely au fait with powered hand and machine tools – would also possess a CNC router. The crux of this argument is simply that the adoption of new technology requires a new set of skills, without throwing out the skill and material knowledge inherent in all of the previous technologies.

Is this tipping point similar to the point we are at now? An understanding of what we are losing and gaining is becoming clearer as the technologies develop. Both in loss of tacit knowledge and craft skill and gaining of knowledge of handling a new tool, without losing the fundamental approach to making.

However, we live in a different world: the knowledge required of todays skilled craftsperson is very different from the craftsperson of the past and this knowledge will face rapid change in the future. So, just as Sturt’s time, when the knowledge and skill base that had not changed for centuries, changed rapidly within a few years we too may now experience similar rapid change, engendered by the introduction of a disruptive technology.

The integration of new technology and why
Research from the Centre for Fine Print research

Slide 36

Why then, am I advocating for the integration of new technology and why? Primarily, because the technology is already in place and increasingly will be part of the future of industrial manufacturing. If you take my historical precedents then as printmakers we will eventually adopt it anyway, whether you look at my example of
screen printing or Sturt’s adoption of mechanised technology to make carts. I am just advocating we don’t therefore dismiss it before we seen what opportunities it offers, at the same time realising that the skills we have are incredibly important, whatever the tool, we need the skill. I might add that I believe the advent of new screen printing process was a good thing. Sturt thought the new technology denied the inherent skills of the craftsman. Maybe the future will be the same both good and bad.

Having given you the hypothesis, I am hopefully going to lighten the load by giving you a series of visual examples of how my research centre is applying these thoughts to real process and technologies.

**Slide 37**

We have a long history so I will go back quite a few years to where we started to impact upon what printmaking might be. In the year Two thousand we started a project with re-appraise aspects of historic printing that had been forgotten through the Collotype, Woodburytype and Photogravure processes. All of these processes rely on the very particular attributes of potassium bi-chromate and gelatine and are fundamental to the history of printing processes that can reproduce a photograph. This is very different to photographic printing on paper.

The beauty of adding potassium bi-chromate to gelatine means that the gelatine becomes sensitive to light, the gelatine hardens in direct relation to the amount of light it receives. Gelatine is also hydroscopic, so after exposure to a photographic negative the soft parts of the gelatine can be washed away in direct relation to the amount of light it has received. Unlike the half-tone process where a dot is only either black or white, because the gelatine absorbs water in direct relation to the light it has received it also has the ability to form a random reticulated structure when immersed in warm water and the dried. This process is of particular interest in the collotype printing process, where a thin layer of bichromated gelatine was coated onto a glass plate, the process that was common from the
eighteen seventies to the nineteen fifties. It was possible because of the random reticulation to print as many colours as you wanted with no interference structure and unlike litho the ink was accepted or rejected on the plate in direct relation to how much water the gelatine had absorbed. The process only died out because it was a very difficult to print it required a high degree of skill to print and print runs were in the hundreds not many thousands. We used this process to demonstrate to Hewlett Packard that it was possible to print beyond four colours without an interference pattern and that there were alternative approaches to four-colour separation printing.

Slide 38

This research progressed into a variation of the Woodburytype process, the only truly continuous tone printing process that had ever been invented. This process relied upon a thick layer of the bi-chromated gelatine which when exposed to a negative washed out in a series of tone curves deep where no light had penetrated and shallow where the light had got through. Woodbury then made a lead mould from the gelatine slab in a big hydraulic press, then filled the lead mould with hot liquid gelatine that was pigmented with a translucent black. The resultant print creates tone entirely by the depth of the translucent colour the deeper the blacker. There is no half tone whatsoever.

Slide 39

In turn we translated a black and white photograph to a series of height steps. With white being zero and black being two hundred and fifty six. This was then translated into a CNC milling file and Plaster mould was milled, this was then cast with ceramic slip. When fired and glazed with a translucent glaze a permanent continuous tone photographic ceramic image was created. Again, the tonal photographic image is only created by the depth of the translucent black glaze, in the relief ceramic tile.
Read Slowly

This work in historic process from an arts practitioner perspective had a profound effect on our relationship with the digital ink jet manufacturers. We had been investigating the potential of digital ink jet since Nineteen Ninety Seven and our relationship with Hewlett Packard had grown to an extent that they sponsored my professorial chair and funded some our research, to that the extent, I was classed as an industry influencer by HP. By this point we also had relationships with Canon, Roland and to a limited extent Epson. One of the things this relationship created was we had a say in the development of twelve colour wide format printing and to help our work HP gave us a series of pre-release Beta machines.

Slide 40

Amongst other things we used these machines to work with a series prints with well known artists in particular the farther of Pop art in the UK Richard Hamilton, whom we worked with for the last twelve years of his life. Our first project with Richard was to create an ink jet version of his translation from French of Duchamp’s Large Glass.

Slide 41

He had tried many other digital printers and nobody else could get a good black from his at the time massive illustrator file. Using help from HP we worked out a way of keeping the file unconverted and in RGB right up to the print stage thus retaining the integrity of Richard’s intention.

Slide 42

We went on to make many more prints with Richard, in particular the massive print on canvas of Tony Blair called Shock and Awe, for which we had a very special ink jet coating made for Richard’s favourite Belgian canvas that HP coated for us in San Diego.

Read Slowly
Our next step was to create a digital photographic image onto glass enamel on metal we are now at about 2003 and this was the early days of digital ceramic transfers, using ceramic oxides in the laser toner to make a photographic image. To both investigate the potential and to promote printed enamel on metal we installed a 2 metre by 1 metre kiln, because we could make public artworks of a large permanent size we worked with well known artists, such as the ceramicist Richard Slee,

where we made digitally photo-printed transfers applied to traditional workmen’s hand tools, Spades, saws and trowels.

We also worked with the fashion illustrator Julie Verhooven, who created this series of panels for a complex of flats in the centre of Bristol. Julie wanted to combine screen printing, digital photo transfers and hand painting all on the same panels, an interesting technical challenge say the least especially as most of the panels were at least a metre square or larger.

To return to digital printing Roland were very keen for us to push the limits of their new solvent printer that would print and cut heavyweight vinyl. In addition John Phillips from the London Print Studio was undertaking a project that celebrated the two hundredth anniversary of the abolition of slavery. He wanted to recreate the image of a slave ship that had helped William Wilberforce to bring about the abolition of slavery, using a multi-ethnic group of school children from West London.
The image was over forty feet long and in two parts for the different slave decks. We individually printed and cut each child in reverse and backed them with an extra layer of white vinyl so that the image could be stuck to the inside of the window, but viewed from the outside both in daylight and at night. The whole image was backed onto a release paper in order for it to be accurately applied to the window.

Concurrently to the enamel on metal, we had been investigating laser cutting for artists for some time. The best way to illustrate this is to show you some of the work we undertook with the American artist Lesley Dill.

Lesley’s intention when she came to us was to push the boundaries of what she had undertaken in other studies to new limits. One of the most successful was a straightforward laser engraved image. It is possible to engrave to eight levels of grey with the lasers we were using. If we made a light, mid tone and dark version of the image, we found that we could engrave to twenty four levels of grey. Thus creating a much more detailed image.

The two big projects Lesley was keen to undertake, were a gold book that lit up as you turned the pages and a print on Japanese paper that lit up as you walked towards it and faded away as you walked away. At the time that was quite a challenge, we achieved it and managed by Ink jet, laser cutting, and some sophisticated electronics to create an image in a frame with no visible sign that it contained any electronics.
Today with the advent of Arduino an open source hardware and software programmable project kit. It would have been very much easier to achieve.

By Two Thousand and Seven, we decided it was time to investigate 3D printing, this fortunately coincided with an opportunity for a large investment in capital equipment from the UK government. As you might imagine this was just before the crash in Two thousand and eight. I was able to buy a series of 5, 3D printers ranging in cost from several thousand euros to over one hundred thousand. Our primary goal was to assess the technology from a visual arts perspective and we quickly realised that the major problem was the poor quality of the printed materials, whether, extruded, ink jetted powder or photo-polymeric curing.

I want to show you three projects that bore fruit and demonstrate why we found the materials poor. Firstly we worked with Richard Hamilton on a medal of Dishonour, which was commissioned by the British Museum. (Something the British Museum has regularly done for many years). Richard wanted to create a medal with a photographic image of Tony Blair in Relief on one side and Alastair Campbell on the other side with the word whitewash written in Latin. This was a comment on the death of Dr Hutton who committed suicide over the weapons of mass destruction enquiry.

We tried every form of 3D printing to create a master mould and none was crisp enough or gave the right appearance. So in the end
we CNC milled the digital file much in the way we had made the ceramic photo tiles and the medals were cast from these moulds.

In tandem with this project we were researching a method of 3D printing ceramics for which we have owned a patent for a number of years. In order to create a material that was in our terms real for artists. To demonstrate the quality of the process we developed we worked with the ceramic designer Peter Ting, who designs for Aspery’s Tiffany’s and Royal Doulton among others. He created a double wall porcelain bowl that could not have been created any other way. Both of these projects were shown in the Seminal New York Museum of Art and Design exhibition Out of Hand.

It was during this exhibition that our third example came to fruition, we were working on a 3D printable ceramic version of the ancient Egyptian material Faience. To demonstrate its quality we had scanned a pencil eraser of a famous Hippopotamus made from Egyptian Faience that is one of the prize exhibits in the Metropolitan Museum of Art in New York. We had then 3D printed the hippo in our version of faience. A curator from the Egyptian department saw it and they thankfully saw the funny side of what we had created. We then had a discussion about scanning Faience amulets inside mummies and recreating them to demonstrate that, which could not be seen inside the mummy. Unfortunately we have still to follow this up.

Now we get to the most recent and therefore possibly the most contentious, certainly the most difficult to understand where the research is intended to take us. As academics we wish to understand what constitutes the fundamentals of print and tacit understanding
combined, and can they be reproduced, without the hand of the artist, not to replace the artist but to give us a greater understanding of how we use tacit knowledge and to what extent is the analogue or random nature of creating an image essential to our aesthetic appreciation, Why is it we have much more affection for a print, painting or drawing than a reproduction of that image.

Therefore as a natural progression of our work in 3D printing we are using the programming skills of robotics. In this case we are using robotics to programme a machine to print, paint or draw for you. In one sense, it is possible to argue that this has already happened for many years. The British artist Harold Cohen produced many computer generated prints in the Nineteen sixties and Seventies, likewise Richard Hamilton created Five Tyres remoulded in Nineteen Seven-six using Fortran and a CNC machine. However there is a clear difference between those computer generated prints and programming the computer to make its own decisions and to create an autographic mark that is impossible to recreate again, much as a human signature. It would be perfectly possible to argue that any print we send to an ink jet or laser printer. Or in 3D terms and file we send to a 3D printer or CNC machine is performing exactly the same tasks as those early computer drawing machines or most of the current crop of machines that will draw or paint an image.

To return to the analogy of a signature, as we have been working on those for a couple of years. Our robots will generate a path from an image that only has a few set points that it has to cover the pencil or paintbrush can then deviate from this path as it draws. These points are the minimum required that will still produce a recognisable signature, The deviation relates to the amount of tension or force that the pencil encounters as it is drawing. This means that each drawing is different from the last, but still retains the same visual elements, much as each print we make can differ slightly.
The next development from the drawing machine was a painting machine that can incorporate some of this deviation. A photographic image is inputed into the software, which then isolate the colours that make up the image, this can be as few as two through to twenty or thirty different colour.

Slide 62

Once it has isolated the colours the programme than decides the shape and surface texture of those marks. Not as in a digital file one square of colour next to a square of a slightly different colour. Once we have that information a file is generated for each separate colour and the machine starts to draw or paint. Built into the software again is a degree of what you might call bounce or ability to overshoot depending on the resistance met by the brush or crayon. We are conscious that if painting the machine should build the image in layers and we take into account drying times and how the colour may change as the machine is dipping into and crossing previous colours.

Slide 63

This research is in its early stages, but I wanted to give you a flavour of where we are heading in our explorations of the future for print. As usual we are working with artists as we go. For the past few months we have been working with the British Artist Peter Blake on a sequence of prints, relating to the drawing and painting machines. Unfortunately due to confidentiality, I Cannot show you any images but this is one of our trial watercolour images to demonstrate what the machine is capable of. I also have a few images of our trials with different paints and surfaces.

Therefore to summarise, what I have shown you, I believe that the future of print and printmaking is very healthy. I have previously stated that Ninety five percent of the world at least is still physical and always will be. The advantage for the printmaker is that the print
Read Slowly

is both visual and tangible, it is not possible yet for anybody to say that the virtual is a replacement for the physical experience we get looking at a great print in the flesh.

Thank You very much.