Feedback from engineers on impact of the case illustrations

Feedback was received from 5 engineers who had access to the case illustrations and some accompanying video recordings of the interviewees moving around their homes.

Four of the engineers were post doc researchers who were new to the field, the fifth, Tom, was a Professor with prior experience of designing devices for people with impaired mobility.

They answered 3 questions: the first about the ways in which the case illustrations influenced their thinking; the second about whether they would recommend the use of case illustrations for future projects and thirdly asking for any changes they would make to the process.

Please note all names are pseudonyms.

Question I.

In what ways did the information provided by the case illustrations for the face to face interviews /inform /influence your work for this project?

Colin (post doc Mechanical engineering) provided some specific examples of how the case illustrations influenced his thinking. Note: all names given in Tim's comments are pseudonyms.

Interviews with elderly people) suggest an apprehension towards ARTs, and it seems the most important positive for Francis and Gwen would be an increase in confidence. ARTs will likely need to be especially unthreatening and attractive to be used by this user group.
Increased confidence provided by e.g. a device that detects fall and protects the user from injury might be attractive, allowing users to feel confident (Alex), particularly when away from known environments such as when on trips (Francis, Gwen)
All illustrations where people who have had strokes are interviews mention the problem of not knowing where the affected leg or foot is without looking at it. This requires constant concentration to walk, Paul in particular mentioning that the constant mental energy used to do this is what tires him the most. An ART that 'guides' the leg or foot during movement could target this challenge, and this would not require large forces and powers compared with an ART that provides power for e.g. sit-to-stand. Thus it could be thinner and lighter than a 'power' ART.
Diane and Paul mention their desire to walk faster when walking with family and friends, and the uncomfortable feeling of having others wait for them. Again, compared with ARTs for sit-to-stand, an increase in walking speed could be achieved with a thinner and lighter ART. The ART thickness/lightness would be proportional to the walking speed improvement so more discussion might be necessary to find the 'sweet spot'.
Diane and Paul describe how tiring standing can be, for example when brushing teeth or doing the washing up. ARTs that 'stiffened' to provide some support during these activities could extend stand duration and prove useful. Stiffening can often be achieved without using too much energy since no mechanical work is done, so again ARTs could be thinner and lighter if they only stiffened and did not provide power.

All illustrations mention ease of putting on as an important issue
Alex mentioned the 'faff' of his foot-up device, highlighting the potential for a smart sock to counteract foot drop to be useful.
Initially, my thoughts were focused upon 'power trousers', and how best to provide the mechanical energy required for sit-to-stand manoeuvres in a wearable device. While this is still an important part of the project, reading through the case illustrations provided evidence for the large number of possible devices that could be developed that could improve the lives of people with reduced mobility, particularly lower power devices, which could 'guide' and stiffen and which, because of their lower power requirements, could be thinner, lighter and more comfortable.
The videos (Paul and Alex) were especially useful for getting an intuitive understanding of the challenges faced by people with reduced mobility, and I'd particularly like to thank the interviewed users for providing these.

The others answered more generally:

Robert (post doc bio-robotics):

We have to demonstrate a solution for each challenge, but they should not necessarily be merged in a single garment, because the requirements vary from person to person.
Having comfortable trousers is important as much as the technological parameters like deliverable power and functionality are.

Ailsa (post doc manufacturing research) answered referred to herself as Maria:

The illustrations describe the mind-set of the people that will be using the trousers and socks and it has helped Maria think more practically and she comments that as an engineer she can get ahead of yourself. The illustrations provide the bigger picture and tells her what the users are expecting. These enable Maria to be more focused and targeted in her outlook for the final material for the project.

Tom (post doc robotic control)

First of all, I think this is a great work. The answers from the interviews and videos allowed me to see and feel the concerns and the difficulties that participants have to deal with every day. Also, comments from participants made me to see the challenges of this project from a different perspective.
I consider that comments from participants provide extremely important information for all partners of this project. But from the point of view of perception and control, safety and

adaptability are crucial and challenging. Comments from the interviews have made me think that maybe some bio-inspired methods could provide some initial solutions to have a system capable to deal with safety and adaptability, which also would allow participants trust in the wearable robotic devices.
Definitely, we will have some wearable devices that will provide assistance but, from what I did see from the interviews, I think we will also need procedures or training sessions that make participants feel 100% safe and gain confidence for walking.
The interviews were very useful because they allowed me to know the aim, objectives and challenges observed from the point of view of each project partner. Specially, interviews helped me to identify the challenges for the design of control systems and to realise what it is feasible for this project.
These were also very useful to identify potential subgroups, collaborations and publications between project partners.

Joe (Professor of Applied Control within Electronics and Computer Science)

Provided a useful summary from a personal perspective. I've done a lot of reading around lower limb impairments (in terms of FES and robotic assistance) over recent years, so there was not much new to me. However, reference to devices like "foot-up" was very useful indeed.
Highlighting every-day barriers and challenges to movement was interesting, as some were not obvious.

Question 2

Would you recommend using case study method (where we interviewed people face to face and then wrote an individual Illustration for that person, to illustrate individual's experiences) for future similar projects?

All 5 answered *Yes.*

Question 3

Colin	*"Clinical and social needs" have been identified but more quantitative information would be useful for designers. For researchers designing the ARTs, more specific descriptions of requirements and acceptable sizes and weights would be useful, for example: how much faster the user would like to walk, or how much slower are they currently compared family and friends, how long they would like the ART to last before needing to be recharged, what weight of power supply would be comfortable to carry, etc. However, these are all are very difficult to quantify and design questions for / give answers to for users, especially because the ideal answers are always "as fast/long/light/ as possible". Furthermore, the answers would vary significantly between users. Possibly it's simply not possible to get answers to these technically orientated questions through user studies, while maintaining a respectful and reasonable interview method. However, as designers getting answers to these questions would be immensely helpful when making design decisions such as what technologies to use in the ART. This isn't really something where I can suggest an alteration since I don't know how best this can be addressed!*
Robert	*No suggestions for changes*
Ailsa	*The user work has been done extremely well. She advocates video use as well to illustrate the case of mobility… more needed e.g. what does an impaired ankle look like? Videos would enable mobility problems to be seen and how to tackle them as an engineer.*
Tom	*I think would be useful to have a ranking of requirements provided by users.*
Joe	*No suggestions for change, but a comment on usefulness Especially for engineers who have very little experience with users, and when we have technology to test, these will be invaluable. Because I've had some (but not deep) exposure to lower limb impairment, most of the information was known to me. However, it has certainly provided a useful "high level" summary of the major requirements will inform my/our work in producing an engineering specification of the device.*