Disability Interaction (DIX): A Manifesto

Disability has often spurred designers to create novel technology which has later become universal; for example, both the typewriter and the commercial email client originated from a need to communicate by blind and deaf people. The design constraints imposed by disability have pushed ingenuity to thrive within the design process. Recent technological advances in AI, Internet of Things and pervasive computing provide great scope for designers and researchers to explore this symbiosis when considering future innovations for disability as well as for society at large. Here, we propose a new agenda for harnessing such opportunities; we call it Disability Interaction (DIX). DIX views disability as a source of innovation, one which can push the boundaries of the possible.

Increasingly mainstream products and services which create content, and allow for its absorption, are becoming inclusive. This cultural shift can be seen in the accessibility options offered by Microsoft (e.g. prompting for alt text captioning), Google (e.g. Chrome's built in ChromeVox screen reader) and Apple (e.g. LiveListen, which turns the iPhone or iPad into a remote microphone that sends sound to a paired, compatible hearing aid). Simultaneously, new use cases addressing challenges faced by disabled people are driving technological developments. Wheelchairs are becoming part of the Internet of Things (see Figure 1). Microsoft have used artificial intelligence (AI) to create SeeingAI, a visual assistant for visually impaired people. There is a changing mindset.

This change in mindset, attitude and policy is also being helped by major world events such as The London 2012 Olympic and Paralympic Games. These were an inflection point, changing the perception of disability in the UK, and arguably throughout the world. They were the most accessible Games and the Paralympics was sold out for the first time in history. This was achieved by a combination of mainstreaming and mission setting. Accessibility and inclusion were not 'nice to have', but essential, built into contracting and delivery targets. The success of the

Games was also enabled by the co-design of programmes, policies and places with local and disabled people. This approach is central to our vision of HCI for disability innovation: exploring what happens when diverse communities of people are empowered to creatively shape and develop new mechanisms to achieve accessibility and inclusion, themselves.

Assistive technology is also being developed in new and exciting ways. The maker community is playing an interesting role within this space. An early example is the Enable Hand project (http://enablingthefuture.org/) , which allows people to create their own prosthetic hand. The initial idea was given away for free, repurposed, adapted, enhanced and ultimately made locally using 3D printing. This bottom-up approach to innovation is enthusing a generation of people to design their own solutions; and to share these to allow others to further evolve the design. Digital manufacturing combined with advances in the Internet of Things, robotics, virtual and augmented reality, and low power sensing are each opening up new and creative opportunities to address inclusion.

The time is ripe for HCI to lead the way in making the world truly accessible and inclusive. To do this there is a need to move beyond discipline-based enquiry, and even transdisciplinary investigation, to one where disciplines no longer provide the framing but are replaced by issue-based design, drawing on specific disciplinary methods as and when required [2]. We term this new undiscipline, *Disability Interaction (DIX).*

Below, we first set out the argument for DIX with a critique of the current interactions between technology and disabled people; and second, we start to explore what is possible through designing disruptive technologies for inclusion.

Interactions, Accessibility and Disability

Creative solutions which allow disabled people to use computers, and technology more broadly, are usually captured under the term 'accessibility'. They can be categorized into: (i) *assistive technology (AT)* targeted at a specific person or a subset of people, and (ii) *inclusive (universal) design* approaches which incorporate accessible design features into the mainstream product or service. A classic example of the former is the use of screen readers which make available content to blind and partially sighted people. Such technology has been widely

praised since the 1990s but (until very recently) was a form of AT that required specialized software, more recently this has become a mainstream offering of inclusively designed products. The universality of the Internet has had the most widespread impact: enabling easy information access to disabled people. However, while the web has democratized how content is created and shared, it also means anyone can create a website and, by the same token, can create an *inaccessible* website. Both the screen reader and the internet depend on the creation of accessible content. To ensure website accessibility developers need to be aware of *and* implement accessibility standards (e.g. WAI - ARIA). However, this rarely occurs; and most websites continue to breach basic accessibility standards.

Globally, just 10% of the people who need AT have access to it representing "one of the most pressing problems facing the global health sector" [5]. So how do we make technology accessible to all such that it is not the exception but the norm?

First, we need to overcome the stigma associated with using an assistive product by designing more inclusively. Stigma contributes to the generally agreed figure that a third of all AT is abandoned by users [7]. Stigma in many cases is fuelled by ignorance of what disability is and the ways in which AT can help, therefore an essential part of reduction of stigma is the mainstreaming of disability. Stigma is captured within the World Health Organisation's International Classification of Functioning (ICF) as a deterministic factor in preventing participation. The ICF, is a bio-psycho-social model of disability which captures the dynamic nature of both functioning and disability. It offers a way of working around the previously dichotomous viewpoints of the medical and social models of disabiltiy. Within this framework disability arrises when there is a negative interaction between an individual's capabilities (which arises from their health condition) and the contextural factors at play when undertaking an activity (e.g. environmental and personal facorts)[11]. The impairment just means a person has a different spectrum of capabilities than has been catered for in the design process. AT, designed specifically to overcome an *impairment* or a lack of a function, can by its very nature create unexpected forms of social exclusion when it is designed for disability rather than for people [4]. We propose a new lens, viewing AT as an extension of the mind and body as defined by Clark and Chalmers [3], where the technology creates an *external coupling* with the user and becomes a constant in

the their life. This reframing allows for the new paradigm of DIX to emerge: to create technologies to extend people's capabilities, rather than specifically designing for impairment.

Second, we need to overcome social exclusion. Within the context of the ICF participation in activities can be restricted by a range of medical, environmental, personal and social factors. In the Global South there is a critical mix of these factors at play leading to an established and strong link between disability and poverty [1]. However, it can also be seen in a lack of interactions within the Global North. For example, disabled people are generally less likely to be confident in their use of the Internet, less likely to own a laptop or desktop and are more likely more likely to say they never go online compared with their non-disabled peers (23% V's 8%) [6].

Third, we need to find ways of including disabled people in the design of the emerging smart technologies. Most people, globally, now live in cities, and increasingly these are becoming 'smart'. Such movements offer a huge opportunity to ensure the systems we embed into cities are accessible from the start. For example, the open standard for developing audio navigation applications (Wayfindr, https://www.wayfindr.net/) will allow future designers of indoor navigation systems to make their technology readily accessible to blind and partially sighted people. Additionally, it will also aid people with a temporary impairment.

These strands of research have until now been based in separate disciplines, with researchers working in multi-, cross-, inter- and trans-disciplinary teams to attempt to tackle the problems. As the world becomes increasingly digital, a new framing is required where HCI sheds the shackles of strict disciplinary practices, to create a new *undiscipline* of Disability Interaction (DIX).

Figure 1. ARCC, an example DIX project (www.arccs.org) which turns a wheelchair into a part of the Internet of Things to automate accessibility mapping of cities

The time is now

It has been proposed that a combination of basic and applied research can

help reduce the barriers to technology or innovation commercialization [9]. To drive change the choice of problem is critical: it must to be 'actionable' and must address 'civic, business and global priorities' [9]. DIX addresses exactly such challenges, which are set within a broader global Sustainable Development Goal's agenda to ensure 'no one is left behind'. Part of our proposed new approach will require the reframing what does it means to be disabled and, by the same token, what does it means to be inclusive. Moving beyond the common-language and classification framework given by the ICF to the development of inclusive technologies which blur the boundaries between disability and additional ability, and across functioning domains.

To begin, DIX will start by building a deeper understanding of actual user needs in relation to what new technology opportunities there are to address them. The creation of disability innovations will entail personalization and 'remixing' of designs along the philosophy of *one-size-fits-one* rather than *one-size-fits-all*. DIX will grow as the technology for digital fabrications advances and the costs decrease.

DIX Principles

Disability innovation is more than simply the production of a product, a service or a policy. DIX will enable the creativity of diversity to inspire a global movement. Drawing from the literature and – importantly – practice in the fields of HCI, Participatory Design and Tech4good, the following initial principles are proposed:

1. Be open to radically different interactions: DIX will utilize Saffer's four types of Interaction Design practice [8] – User-Centered Design, Activity-Centered Design, Systems Design, Genius Design – to co-create completely new ways to interact with technology
2. Acknowledgement that Disability Inclusion is a wicked problem. DIX will acknowledge that the outputs of DIX can hinder and help the cause of disability inclusion, and that in it is possible to do both. Therefore, wherever possible it will seek to fully understand the full context within which technology is being designed and will continually seek to define the value this is adding to people and society (see 4).

3. Co-created solutions. DIX will work with disabled people and disabled people's organizationsn to define the problem, create the solution and form a community of practice which evolves the solution.

4. Value use and usefulness. DIX will focus on designing *things* that get to and are used by disabled people. Currently technology is often inaccessible due to a lack of demand, not need [5]. To enable demand to grow the value to society of the *thing* (e.g. increased wellbeing, access to livelihoods and education) must be captured to create sustainable models of disability innovation more broadly.

5. Open and scalable. DIX will harness the power of ICT, and the maker movement as it moves towards a distributed design and manufacture model [10] of production to ensure it reaches to as many disabled people as possible.

Figure 2: An example DIX Project: 'Brave boy Billy', an augmented reality art piece telling young wheelchair user's stories by artist Jason Wilsher-Mills

The benefits of DIX

The benefits of DIX will not only be enjoyed by disabled people, but by everyone. Technological advances driven by DIX investigations can open up new areas of research and innovation. DIX can provide a methodology which develops basic and applied research alongside each other. DIX will co-create the problems, define problems for communities to galvanise around and demonstrate new economic models of valuing the development of technology. In short, DIX will be better for inclusion, better for innovation, and better for societies, too.

A Research Agenda

Pressing questions, we will begin with are: How do we design with disabled people who are hidden from society? How do we create AT that has a positive impact on a person's psychological as well as physical wellbeing? How do we use technology to help overcome stigma and discrimination experienced by disabled people? How can we create technologies which are usable in low resource settings? How can we generate data which can inform policy? How do we democratize access

to technology which assists disabled people?

Ultimately, our key line of enquiry is *how do we develop design practices which result in products and services which support the inclusion of disabled people in all aspects of life*?

An Action Plan

Below is a preliminary roadmap showing how we will start to address these questions through a 6-pronged attack:

- *First, learning from what has been done.* Disability Innovations may not always be global, but they are happening in numerous pockets in the world. We will bring together disability innovators globally as well as the larger companies who are developing new inclusive platforms; consolidate their knowledge and develop a common framework of DIX. We will map barriers and enablers to successful technology diffusion. Furthermore, we will develop an overarching hierarchy of DIX which would show both the forms of interactions, the barriers and enablers to technology adoption and critically who in the world has access to which products and services. The aim is to fully understand how to unlock successful technology diffusion for products and services to people globally across a range of income levels.
- *Second, create a new body of knowledge with disabled people through exchange of ideas between people who have domain-specific knowledge relevant to DIX*. From digital health we can learn about the barriers to personalized medicine, from neuroscience we can learn about the adaptations of the brain to impairment, from international development we can learn of the challenges of deploying technology in resource poor settings. We can also learn from medical professionals who understand particular functional losses such as hearing, sight, motor function. Equally we can learn from engineers about new technologies which will allow for new forms of interaction and from the maker movement on how to grow communities of practice.
- *Third, study the problem through 'in the wild' studies testing co-created solutions with local communities.* We need to develop new

platforms for novel empowering interfaces and interactions, and use sensing technologies which are readily available, or easily created, to capture user-experiences in a range of different contexts. The resulting new knowledge will be used to build innovative models of DIX, mapping as we learn the disruptive uses of technology.

- *Fourth, develop mission statements from the collective user-experiences for the global community to solve.* We will create an open-source community of researchers and innovators to co-develop research and design protocols with disabled people, building on human-centered interaction design protocols. These will detail empirical methods for measuring usefulness and usability of new DIXs and methods for scaling beyond the initial context where appropriate. This user-centered, collective-commons approach to research will necessitate the adaptation of current methods and might require the development of whole new methods.
- *Fifth, co-create with disabled people curricula for DIX which can be used globally to train people in how to become creators of new DIXs.* We plan to create a global community of people who can contribute to the development of curriculum for DIXs which could be integrated into the research and development cycle providing a continually updating loop of knowledge exchange between our theoretical understanding and empirical findings. This will be led by disabled people.
- *Sixth, develop new theoretical models of DIX* that build on pre-DIX disciplines of accessibility, inclusive design and assistive technology and enhanced by empirical and theoretical advances in DIX. The resulting models will drive further research questions and insights, evolving the research manifesto put forward here.

An Invitation

DIX puts disability front and center of the design process, and in so doing aims to create accessible, creative new HCI solutions which will be better for everyone including poor communities, which many disabled people are likely to be part of. DIX design, presents significant challenges and will require a global network of

researchers, users and collaborators to succeed in reducing the inequalities faced by the world's 1 billion disabled people. If you would like to join this movement, which is determined to achieve breakthrough technologies that will ensure no one is left behind, you are warmly invited to join the community: www.DisabilityInnovation.com/Research/DIX/

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