Breadth, Depth and Height: Early Findings on Engaging Disabled People with Digital Fabrication

Nick Taylor
DJCAD
University of Dundee, UK
n.x.taylor@dundee.ac.uk

Philip Connolly
Disability Rights UK
London, UK
philip.connolly@
disabilityrightsuk.org

Joe MacLeod-Iredale
School of Arts and Media
University of Salford, UK
macleod.iredale@gmail.com

Ursula Hurley
School of Arts and Media
University of Salford, UK
u.k.hurley@salford.ac.uk

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Abstract
In this paper we describe early findings from a series of digital fabrication workshops run with disabled people as part of the *In the Making* project. These workshops aimed to engage more disabled people with digital fabrication and explore how they might take advantage of it to improve their own lives. Our formative findings point towards a model of *breadth*, *depth* and *height*, indicating different levels and methods of engagement.

Author Keywords
Disability; digital fabrication; 3D printing.

Introduction
The falling prices and rising public awareness of digital fabrication technologies means that more people than ever are able to begin engaging with these new technologies and understanding how they might be able to benefit from them. One area that has already demonstrated strong potential is the use of digital fabrication by the disabled community. In particular, a large body of research has explored DIY assistive technologies (DIY-AT), where digital fabrication allows rapid and cheap customisation of existing assistive technologies or even the creation of entirely new solutions [1,3,4,5]. The E-Nable [2] network even

Figure 1. Workshops began with non-digital activities exploring creativity.

Figure 2. It was important that all participants created something personally meaningful, even if was only simple.

connects people in need of prosthetics with makerspaces who are capable of fabricating them.

However, we believe there are potential benefits outside assistive technology, particularly economic and wellbeing benefits. These possibilities begin to address the more societal and cultural challenges that disabled people face. But achieving this requires more than just the provision of digital fabrication services for disabled people and necessitates engaging them with fabrication itself and supporting them in applying it to their ambitions. This paper describes our early experiences of attempting to support this goal.

The *In the Making* Project

Our project began with a simple idea: what if in 1986, just as computing was beginning to become accessible to the general public, we had made a concerted effort to engage disabled people with computers and develop their IT skills? Although digital technologies have already had myriad benefits for the disabled community, such an early focus on skills might have put them in a stronger positioned to take advantage of the new jobs and opportunities for entrepreneurship created by the computing revolution, leading to increased employment and economic prosperity.

30 years later, we're potentially on the cusp of another revolution driven by new technologies: digital fabrication. Although there has been much discussion of the potentially game-changing nature of this technology—particularly regarding the ability of individuals to create innovative products without major investment—it is still in a nascent stage. As was the case in 1986, people developing skills now will be on the forefront of this revolution and best placed to gain from it. *In the Making*[1] is an 18-month scoping project that asks how we can enable disabled people to engage with digital fabrication and develop these skills now.

The first stage of the project involved a survey of makerspaces to identify existing use by disabled people, areas of potential and challenges preventing adoption. Our key finding was that the benefits of engaging with makerspaces extended far beyond the act of making itself, supporting individual wellbeing and contributing to civic life outside the makerspace [7]. For people with disabilities, who can often be excluded from some areas of public life, this indicated some clear additional benefits beyond the economic argument.

In the second stage, we ran seven two-day workshops with small groups of disabled participants, held in various community centres around Salford in North West England. These were primarily based around 3D printing, as this was the most mobile technology and one that had grabbed the public's imagination.

Preliminary Findings

Over the course of the workshops, we have worked with a variety of different participants and refined our approach to engaging people with the. Taking cues from the three dimensional nature of the workshops, we describe some early observations and lessons learned in terms of three dimensions of engagement: *breadth*, *depth* and *height.*

Breadth

Breadth refers to the diversity of people able to engage with digital fabrication. One of the greatest challenges

[1] www.inthemaking.org.uk

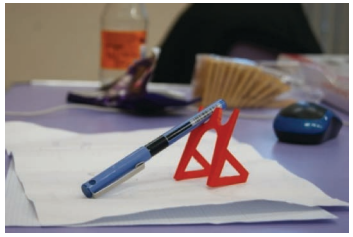

Figure 3: Many participants arrived with specific ideas for assistive technologies they wanted to create.

Figure 4: Other attendees made more abstract creations.

in working with disabled participants is the sheer diversity of disabilities that might be present and preparing workshops that can cater to this range. Although it has been suggested that digital fabrication opens up possibilities for people with physical disabilities who would be unable to use traditional tools [5], the reality is that using the equipment remains physically involved (e.g. changing a filament spool). Additional challenges are posed for people with intellectual disabilities due to the complexity of the software involved [6]. However, as we were working with a charity that represented the rights of all disabled people, there was never any question of limiting the workshop to people with specific disabilities.

The solution that developed across the series of workshops was a combination of non-digital activities (e.g. clay or poetry) to introduce creativity generally and 3D printing activities based on template files (e.g. personalised key fobs). In later workshops, the most successful approaches combined these activities by 3D scanning non-digitally created objects and modifying them in software. This minimised the use of software while still creating something that introduced these technologies and their capabilities. Our goal was to ensure that every participant left the workshop with an object that was personally meaningful to them.

Depth

Depth refers to the ability of participants to further develop their skills beyond the baseline that can be conveyed to all participants. Almost by definition, the goal of in-depth engagement is at odds with breadth of participation, as advancing beyond a certain point inevitably surpasses the abilities (or interests) of other participants. However, for others, who may arrive with some existing experience of design or manufacturing, the simple activities described in the previous section can be limiting and frustrating.

Although the majority of participants attended largely out of curiosity, a smaller number arrived with specific things that they wanted to create and wanted to know how digital fabrication could help them. Our main way of supporting this was to have a product designer on hand who was able to spend a significant amount of time with each participant helping them to generate more ambitious designs. Several participants were able to create prototype assistive technologies in this way. Other participants chose to attend multiple workshops over which they could develop their skills and attempt more ambitious projects.

Ultimately, one of our key goals in this project was to encourage participants to make use of the local Fab Lab. We aimed to take participants as far as we could with limited time, but primarily aimed to introduce the core concepts and possibilities and ignite enthusiasm that would lead them to pursue it further.

Height

Height refers to the onward ambitions of participants to take advantage of their new knowledge to improve their circumstances. Although the scope and duration of our project precludes any major breakthroughs in this area, we have been led to consider how the project can leave some form of legacy behind.

As discussed above, one of the primary ways of doing this is to act as a route into existing fabrication facilities and maker communities. However, the project also has its own equipment, including two 3D printers and a

number of 3D scanners, that we intend to leave in the community after the project has concluded, most likely in service centres that combine libraries and other council services. Having these facilities locally, rather than on the far side of nearby Manchester, is particularly important for people with mobility problems, which was true of many of our participants.

In addition to making this equipment available, it is important to build associated skills and enthusiasm. Otherwise, the equipment will most likely remain unused. We have had some successes in creating 'pioneers' who can utilise the equipment and demonstrate to others. For example, one participant ran a charity organising activities for people with autism and attended with a number of her clients. Subsequently, she has begun attending the local makerspace with one of her clients and has taken on an unofficial 'greeter' role when she saw the difficulties new attendees could have. However, helping people to make the jump from low-level engagement to taking full advantage of the technology remains challenging.

Future Work

Although the scoping project is now coming to a close, further analysis of the workshops may suggest further possibilities. One particularly interesting possibilities follows interest from both local and national government, which opens the possibility of embedding digital fabrication within existing offerings for disabled people and reaching a much broader audience.

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References

1. Erin Buehler, Amy Hurst, and Megan Hofmann. 2014. Coming to grips: 3D printing for accessibility. In *Proceedings of the 16th International ACM SIGACCESS Conference on Computers & Accessibility* (ASSETS '14), 291–292. http://doi.org/10.1145/2661334.2661345
2. E-Nable. Retrieved September 23, 2015 from http://enablingthefuture.org
3. Jonathan Hook, Sanne Verbaan, Abigail Durrant, Patrick Olivier, and Peter Wright. 2014. A study of the challenges related to DIY assistive technology in the context of children with disabilities. In *Proceedings of the 2014 Conference on Designing Interactive Systems* (DIS '14), 597–606. http://doi.org/10.1145/2598510.2598530
4. Amy Hurst and Jasmine Tobias. 2011. Empowering individuals with Do-It-Yourself assistive technology. In *Proceedings of the 3rd International ACM SIGACCESS Conference on Computers and Accessibility* (ASSETS '11), 11–18. http://doi.org/10.1145/2049536.2049541
5. Amy Hurst and Shaun Kane. 2013. Making "making" accessible. In *Proceedings of the 12th International Conference on Interaction Design and Children* (IDC '13), 635–638. http://doi.org/10.1145/2485760.2485883
6. Richard E. Ladner. 2015. Design for user empowerment. Interactions 22, 2 (March 2015), 24–29. http://doi.org/10.1145/2723869
7. Nick Taylor, Ursula Hurley and Philip Connolly. 2016. Making community: the wider role of makerspaces in public life. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '16). http://dx.doi.org/10.1145/2858036.2858073