

In the making

Digital fabrication and disability

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University of Salford

Series in Sociology



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*bring us new tools then
register us designers*

Scott Thurston, “for Roger Fowler”, PhD thesis

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List of abbreviations

| | |
|--------|---|
| ADHD | Attention Deficit Hyperactivity Disorder |
| AHRC | Arts and Humanities Research Council |
| BBC | British Broadcasting Corporation |
| BSL | British Sign Language |
| BTEC | Business and Technology Education Council |
| CAD | Computer Aided Design |
| CBA | Center for Bits and Atoms |
| CIC | Community Interest Company |
| CNC | Computer Numerical Control |
| DOI | Digital Object Identifier |
| DRUK | Disability Rights UK |
| FabLab | Digital Fabrication Laboratory |
| GCSE | General Certificate of Secondary Education |
| HND | Higher National Diploma |
| JPEG | Joint Photographic Experts Group |
| LCD | Liquid Crystal Display |
| NESTA | National Endowment for Science, Technology and the Arts |
| PLA | Polylactic Acid |
| STEAM | Science Technology Engineering Arts and Math |

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A note to the reader



Figure 1.1. An assistance dog checks out her human companion's design.

Hello. Thanks for your interest in this book. I do hope that you will choose to go on and read it. To help inform your choice, I'd like to offer some indication of who I had in mind when I was writing. The book draws on the findings from a UK Research Council funded project, which set out to explore how disabled people might benefit from digital fabrication technologies, particularly 3D printing. As the book has its roots in a research project, there will be some citations and critical evaluation to help contextualize and evaluate the findings. However, this text is not just for academics! I have tried to write for anyone who has an interest in experiences of disability as they intersect with digital technologies, maker spaces, and/or creative processes. Alongside an account of the research, you can engage directly with the creations and experiences of our project participants. Our investigation was co-constructed with a network of disabled people from Greater Manchester, UK. To honor their contribution to the project, I have foregrounded their voices, images and experiences whenever possible – especially in Chapters 3 and 4. This book is not a technical or scientific guide to 3D printing. Rather, it employs approaches from the humanities in order to explore culturally and aesthetically the process of turning data into things. Some academic theories

and concepts are employed to help me do this. However, I have included ‘take-aways’ at the end of each chapter. So, if the citations ever become too dry for your taste, you can find a user-friendly summary of insights and suggestions in bullet-point form. Whatever your reasons for reading, I hope that the achievements of our collaborators inspire you to consider the potential of digital fabrication in your own context, whether you are an expert maker or someone who is just curious about the possibilities.

Chapter 1

Introduction

Origins

The material in this book was generated by a UK Research Council funded project, “In the Making”, which set out to explore how disabled people might benefit from digital fabrication technologies, and 3D printing in particular. The project began with the researchers visiting digital fabrication laboratories (often known as FabLabs or makerspaces) across the UK to learn about existing practices. We – researchers, collaborators and stakeholders – wanted to find out whether disabled people were already accessing makerspaces and, if so, what challenges they faced. Based on our findings (detailed in Chapter 2), we then organized a series of workshops to explore digital fabrication with disabled people. The research grant allowed us to buy entry-level 3D printing equipment, and expert creative and technical facilitation.

Over an 18-month period spanning 2015-16, we provided 3D printing equipment and approximately 100 hours of tuition to over 100 disabled people, their supporters, families and friends. Our mobile digital fabrication laboratory toured venues in Greater Manchester, a conurbation in the northwest of the UK which includes many communities affected by post-industrial decline. Our venues set out to be non-typical of the usual makerspace, which can imply that only the technically adept are welcome, in order to be accessible to as wide a range of people as possible. Sites included a garden center, the BBC at MediaCityUK, community arts centers and public libraries. In each location we invited people to play with the technology, ask questions, join ideas workshops and participate in training sessions.

The approach throughout was “I can make it”. We used this phrase with conscious reference to the layers of meaning it contains. Alongside the sense of physically making a useful or beautiful object is the abstract sense of “making it” by succeeding in life, crossing the finish line, achieving a goal. We set out to show that digital fabrication can support the “I can make it” ethos through its ability to empower people who are traditionally excluded from economic success and social status (Connolly 2017). With Joe McLeod-Iredale, founder and director of Daedalus Design (<http://www.daedalusdesign.org/>), we developed an inclusive pedagogy entitled “Digital Fabrication for the 99%” (2016). You can read more about this on the book’s website. Everyone, no matter their physical or mental capacities, was supported to be actively

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Bibliography

- Anderson, Chris. *Makers: The New Industrial Revolution*. London: Crown Business, 2012.
- Armson, David. Personal interview. April 29, 2015.
- Babineaux, Ryan, and John D Krumboltz. *Fail Fast, Fail Often: How Losing Can Help You Win*. New York: Tarcher, 2013.
- Baker, Sarah. "‘It’s Not About Candy.’ Music, Sexiness and Girls’ Serious Play in After School Care." *International Journal of Cultural Studies* 7, no.4 (2004): 197-212.
- Barrett, Timothy. "De-individualising Auto/biography: A Reconsideration of the Role of Auto/biographical Life Writing within Disability Studies." *Disability and Society* 29, no.10 (2014): 1569–1582.
- Barron, Carrie. "Creativity, Happiness and Your Own Two Hands: How Meaningful Hand Use Enhances Well-being." *Psychology Today*, May 3, 2012, <https://www.psychologytoday.com/gb/blog/the-creativity-cure/201205/creativity-happiness-and-your-own-two-hands>
- Barron, Frank. *Creative Person and Creative Process*. Oxford, England: Holt, Rinehart, and Winston, 1969.
- BBC. "UN: 'Grave' disability rights violations under UK reforms." *News*, November 7, 2016, <https://www.bbc.co.uk/news/uk-37899305>
- Bennett, Cynthia L., Keting Cen, Katherine M. Steele and Daniela K. Rosner. "An Intimate Laboratory? Prostheses as a Tool for Experimenting with Identity and Normalcy." *Physical Disability and Assistive Technologies* #chi4good, CHI 2016, San Jose, CA, USA. 1745 – 1756, <https://dl.acm.org/citation.cfm?doid=2858036>
- Brady, Ivan. "In Defense of the Sensual: Meaning Construction in Ethnography and Poetics." *Qualitative Inquiry* 10, no.4 (2004): 622–644.
- Briant, Emma, Nick Watson, Greg Philo and Inclusion London. "Bad News for Disabled People: How the Newspapers are Reporting Disability". *Strathclyde Centre for Disability Research and Glasgow Media Unit, The University of Glasgow*, November 18, 2011, <http://eprints.gla.ac.uk/57499/>
- Brown, Bill. "Thing Theory." *Critical Inquiry* 28, no.1 (2001): 1-22.
- Cabinet Office. 2005. "Improving the Life Chances of Disabled People." *Prime Minister's Strategy Unit*, January 2005, <http://www.disability.co.uk/sites/default/files/resources/Improving%20Life%20Chances.pdf>
- Childers, Joseph and Gary Hentzi. *The Columbia Dictionary of Modern Literary and Cultural Criticism*. New York: Columbia University Press. 1995.
- Chittenden, Hilary. 2014. "How to Make a Make Space." *Research and Action Centre, Design and Society*, April, 2014, <http://www.rsablogs.org.uk/2014/design-society/space/>
- Connolly, Philip. Personal interview. 12 Jun. 2017.
- Couser, G. Thomas. "Conflicting Paradigms: The Rhetorics of Disability Memoir." In *Embodied Rhetorics: Disability in Language and Culture*, edited

- by James C. Wilson and Cynthia Lewiecki-Wilson, 78–91. Carbondale: Southern Illinois University Press, 2001.
- Deepwell, Katy. "Hepworth and her Critics." In *Women Artists and Modernism*, edited by Katy Deepwell, 97–111. Manchester: Manchester University Press, 1998.
- Department for Communities and Local Government. "Annual Report and Accounts." *Crown Copyright*, July 1, 2015, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/440498/50208_HC_21_DCLG_2014-15_print.pdf
- Department for Work and Pensions. "Disability Facts and Figures." January 16, 2014, <https://www.gov.uk/government/publications/disability-facts-and-figures/disability-facts-and-figures>
- Devendorf, Laura, Abigail DeKosnik, Kate Mattingly and Kimiko Ryokai. "Probing the Potential of Post-Anthropocentric 3D Printing." *Printing/Proxies*. DIS 2016, June 4-8, Brisbane, Australia. 170-181, <https://dl.acm.org/citation.cfm?doid=2901790.2901879>
- Dickel, Sascha and Jan-Felix Schrape. "The Logic of Digital Utopianism." *NanoEthics* 11, no.1 (2017): 47-58, DOI: 10.1007/s11569-017-0285-6
- DiSalvo, Carl. "Critical Making as Materializing the Politics of Design." *The Information Society: An International Journal* 30, no.2 (2014): 96-105.
- Elliot, Andrew J, and Todd M Thrash. "The Intergenerational Transmission of Fear of Failure." *Personality and Social Psychology Bulletin* 30, no.8 (2004): 957-971.
- Gallix, Andrew. "Oulipo: Freeing Literature by Tightening its Rules." *The Guardian*, July 12, 2013, <https://www.theguardian.com/books/booksblog/2013/jul/12/oulipo-freeing-literature-tightening-rules>
- Gershenfeld, Neil. *Fab: The Coming Revolution on Your Desktop—From Personal Computers to Personal Fabrication*, New York: Basic Books, 2005.
- Gershenfeld, Neil. "How to Make Almost Anything." *Foreign Affairs* 91, no.6 (2012): 42-57.
- Gill, Michael. *Already Doing It: Intellectual Disability and Sexual Agency*. Minneapolis: University of Minnesota Press, 2015.
- Goldsmith, Ronald E. and Timothy A. Matherly. "Creativity and Self-Esteem: A Multiple Operationalization Validity Study." *Journal of Psychology* 122, no. 1 (1988): 47-57.
- Gross, David. "'Mind-Forg'd Manacles': Hegemony and Counter-Hegemony in Blake." *The Eighteenth Century* 27, no. 1 (1986): 3-25, <http://www.jstor.org/stable/41467368>
- Hall, Doug. "Fail fast, fail cheap." *Business Week* 32 (2007): 19-24.
- Haraway, Donna J. *Simians, Cyborgs and Women: The Reinvention of Nature*. London: Free Association Books, 1991.
- Harman, Graham. 2010. "Technology, Objects and Things in Heidegger." *Cambridge Journal of Economics* 34 (2010): 17-25.
- Hielscher, Sabine and Adrian Smith. 2014. "Community-based Digital Fabrication Workshops: A Review of the Research Literature." *Science and Technology Policy Research Unit, University of Sussex*, May 21, 2014, <http://dx.doi.org/10.2139/ssrn.2742121>

- Ingold, Tim and Elizabeth Hallam. *Creativity and cultural improvisation*. Oxford/New York: Berg, 2007.
- Introna, Lucas D. "Ethics and Flesh." In *Ruin Memories, Materiality, Aesthetics and the Archaeology of the Recent Past*, edited by Bjørnar Olsen and Þóra Pétursdóttir 41-61. London: Routledge, 2014.
- Jackson, Carolyn. "Motives for 'Laddishness' at School: Fear of Failure and Fear of the 'Feminine'." *British Educational Research Journal* 29, no. 4 (2003): 583-598.
- Jackson, Norman. *Creativity in Higher Education*. Lancaster: The Higher Education Academy/PALATINE, 2003.
- Jameson, Frederic. *The Cultural Turn: Selected Writings on the Postmodern, 1983-1998*. Verso: London and New York, 1998.
- Kim, W. Chan and Renée Mauborgne. *Blue Ocean Strategy: How to Create Uncontested Market Space and Make Competition Irrelevant*. Brighton, Massachusetts: Harvard Business Publishing, 2005.
- Kneebone, Roger. "When I say ... Reciprocal Illumination." *Medical Education* 49 (2015): 861-862, doi:10.1111/medu.12743
- Landay, James A. "Technical Perspective: Design Tools for the Rest of Us," *Communications of the ACM* 52, no. 12 (December 2009): 80, DOI:10.1145/1610252.1610274
- Lau, Manfred, Jun Mitani and Takeo Igarashi. "Digital Fabrication." *Computer* 45, no.12 (2012): 76-79.
- Leach, James. "Drum and Voice: Aesthetics and Social Process on the Rai Coast of Papua New Guinea." *Journal of the Royal Anthropological Institute* 8, no.4 (2002): 713-735.
- MacLeod-Iredale, Joe. "Digital Fabrication for the 99%." Master's Thesis, University of Salford, 2016.
- Naray-Davey, Szilvia and Ursula Hurley. "Fail Again, Fail Better: The Case for Formative Assessment in First-Year Undergraduate Creative Practice-Based Modules." *The International Journal of the Arts in Education* 8, no.3 (2014): 1-13.
- Nelson, Bryan. "Scientists closer to creating a 'Star Trek'-style replicator." *Mother Nature Network*, 2015, <https://www.mnn.com/green-tech/research-innovations/stories/scientists-closer-creating-star-trek-style-replicator>. Date accessed: 1 May 2018.
- Nemorin, Selena. "The Frustrations of Digital Fabrication: An Auto/Ethnographic Exploration of '3D Making in School'." *International Journal of Technology and Design Education* 27, no.4 (2017): 517-535, <https://doi-org.salford.idm.oclc.org/10.1007/s10798-016-9366-z>
- Phelps, Nicholas A. "The Sub-Creative Economy of the Suburbs in Question." *International Journal of Cultural Studies* 15, no.3 (2012): 259-271.
- Ratto, Matt. "Critical Making: Conceptual and Material Studies in Technology and Social Life." *The Information Society* 27, no.4 (2011): 252-60.
- Richards, Ruth. "Everyday creativity: Our hidden potential." In *Everyday Creativity and New Views of Human Nature: Psychological, Social, and Spiritual Perspectives*, edited by Ruth Richards 3-22. Washington, DC: American Psychological Association, 2007.

- Richards, Ruth. "Everyday Creativity." In *The Cambridge Handbook of Creativity*, edited by James C. Kaufman & Robert J. Sternberg 189-215. Cambridge: Cambridge University Press, 2010, doi:10.1017/CBO9780511763205.013
- Silvia, Paul J., Roger E. Beaty, Emily C. Nusbaum, Kari M. Eddington, Holly Levin-Aspenson and Thomas R. Kwapi. "Everyday Creativity in Daily Life: An Experience-Sampling Study of 'Little c' Creativity." *Psychology of Aesthetics, Creativity, and the Arts* 8, no.2 (2014): 183-188.
- Smith, Hazel. *The Writing Experiment: Strategies for Innovative Creative Writing*. London: Allen and Unwin, 2005.
- Su, Ya-Hui. "Idea creation: the need to develop creativity in lifelong learning practices." *International Journal of Lifelong Education* 28, no.6 (2009): 705-717.
- Symons, Jessica. "Untangling Creativity and Art for Policy Purposes: Ethnographic Insights on Manchester International Festival and Manchester Day Parade." *International Journal of Cultural Policy* 24, no.2 (2016): 205-219, DOI: 10.1080/10286632.2016.1150268
- Symons, Jessica and Ursula Hurley. "Strategies for Connecting Low Income Communities to the Creative Economy Through Play: Two Case Studies in Northern England." *Creative Industries Journal* 11, no.2 (2018): 121-136, DOI: 10.1080/17510694.2018.1453770
- Titchkosky, Tanya. *The Question of Access: Disability, Space, Meaning*. Toronto: University of Toronto Press, 2011.
- Walter-Herrmann, Julia and Corinne Büching, 'Notes on Fab Labs.' In: Julia Walter-Herrmann and Corinne Büching (eds.), *FabLab: of Machines, Makers and Inventors*. Bielefeld: Transcript Verlag, 2013, 9–26. (10)
- Watson, Julia. "Visual Diary as Prosthetic Practice in Bobby Baker's *Diary Drawings*." *Biography* 35, no.1 (Winter 2012): 21-44.
- Weingartner, Charles. "MIND FORG'D MANACLES..." *Educational Studies* 8, no.1 (1997): 21-27.
- Wendell, Susan. *The Rejected Body: Feminist Philosophical Reflections on Disability*. New York: Routledge, 1996.
- Wexler, Alice and John Derby. "Art in Institutions: The Emergence of (Disabled) Outsiders." *Studies in Art Education: A Journal of Issues and Research* 56, no.2 (2015): 127-141.
- Wylie, Sara Ann, Kirk Jalbert, Shannon Dosemagen and Matt Ratto. "Institutions for Civic Technoscience: How Critical Making is Transforming Environmental Research." *The Information Society: An International Journal* 30, no.2 (2014): 116-126.

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