Northumbria Research Link

Introduction to This Special Issue on Open Design at the Intersection of Making and Manufacturing

David Philip Green[1]**, Verena Fuchsberger**[2]**, Nick Taylor**[3]**,
Pernille Bjørn**[4]**, David Kirk**[5]**, and Silvia Lindtner**[6]

[1]*University of the West of England*, [2]*University of Salzburg*, [3]*University of Dundee*,
[4]*University of Copenhagen*, [5]*Northumbria University*, [6]*University of Michigan*

David Philip Green (david10.green@uwe.ac.uk, dpgreen.co.uk) is an interdisciplinary researcher with an interest in co-designing open documentary projects with diverse publics; he is a Postdoctoral Research Fellow at the Digital Cultures Research Centre at the University of the West of England. **Verena Fuchsberger** (verena.fuchsberger@sbg.ac.at, hci.sbg.ac.at/person/fuchsberger/) is interested in the materiality of interactions and the relations between individuals, materials and digital-physical artefacts; she is a Postdoctoral Research Fellow in the Centre of Human-Computer Interaction at the Univerisry of Salzburg. **Nick Taylor** (n.x.taylor@dundee.ac.uk, nick-taylor.co.uk) is interested in the intersection of design, technology and society and the impact of emerging technologies and practices; he is a Senior Lecturer in the Duncanstone College of Art and Design at the University of Dundee. **Pernille Bjorn** (pernille.bjorn@di.ku.dk, pernillebjorn.dk) is interested in the basic nature of collaborative work with the aim of designing collaborative technologies; she is a Professor in Computer Supported Co-Operative Work at the University of Copenhagen. **David Kirk** (david.kirk@northumbria.ac.uk, northlab.uk) is interested in design research methods and the ways in which technology design can be centred on rich understanding of user experiences, cultures and contexts; he is a Professor of Digital Living and leads NorthLab, a highly interdisciplinary Human-Computer Interaction and Interaction Design community based at the University of Northumbria at Newcastle. **Silvia Lindtner** (lindtner@umich.edu, silvialindtner.com) is interested in innovation and technology entrepreneurship, making and hacking cultures, shifts in digital work, labour, industry, policy, and governance; she is an Associate Professor at the School of Information at University of Michigan.

A HISTORY OF OPEN DESIGN IN HUMAN COMPUTER INTERACTION RESEARCH

What is 'open design' and who gets to say what it is? In the emerging body of literature on open design, there is a clear alignment to the values and practices of free culture and open source software and hardware (Green, Fuchsberger et al. 2017). Yet this same literature includes multiple, sometimes even contradictory strands of technology practice and research (Cruikshank & Atkinson, 2014). These different perspectives can be traced back to free culture advocates from the 1970s to the 1990s who formulated the ideal of the internet as inherently empowering, democratizing, and countercultural (Turner, 2014; Coleman, 1999). However more recent approaches include feminist and critical interventions into hacking and making (e.g. Fox, Ulgado & Rosner, 2015; Bardzell, 2015; Toupin, 2014; Söderberg, 2015) as well as corporate strategies of "open innovation" that bring end-users and consumers into the design process (e.g. von Hippel, 2006). What remains today seems to fall into two schools of thought. On one hand, we have the celebratory endorsements of 'openness' as applied to technology and design. On the other hand, we have a continuous and expanding critique of these very ideals and questions, where that critique identifies persisting forms of racial, gender, age, and class-based exclusions, and questions about the relationship between open design, labour and power remain largely unanswered.

Open source has been commonly hailed as a success, as evidenced by its uptake in industry and widespread endorsements of its approach (e.g. Creative Commons, Arduino, etc). Such endorsements show both the excitement that these 'alternatives' to the intellectual property regime have triggered, as well as the ways that they in turn have been reintegrated into a functioning digital economy and platform capitalism (Anderson, 2012). Recently, however, a growing number of scholars and journalists have begun to challenge earlier techno-optimistic ideals. Specifically, they have urged visionaries to account for the role these ideals have played in the furthering of new forms of labour exploitation, be that "free labour" (Terranova, 2004) on Facebook, or "cheap labour" on platforms such as Amazon Mechanical Turk and Uber (Irani, 2015; Scholz, 2012). In 2008, maker and hackerspaces numbered more than a thousand world-wide and open source hardware platforms like Arduino were adopted more widely. At this point, many began discussing the rise of a new hacker and maker movement (Lindtner et al., 2014; Hall, 2010). Specifically, ideals of open source hardware and making arose exactly when earlier techno-utopian ideals began being contested during the global financial crisis and rising job insecurity (Lindtner 2017, Bardzell et al. 2018). Government investment in the maker movement (such as DARPA's funding of Make Magazine) and critiques of 'masculine' computing and engineering cultures (Buechley, 2010; Marshall & Rode, 2018) highlight areas of contestation. Making and open source hardware, in other words, have become a site to confront and contest who gets to say what counts as 'openness', "authentic" innovation, and creativity.

Open design emerges from these very contestations. Within HCI, open design has largely been regarded as an ideal platform to advance earlier commitments to openness by promoting computer-controlled fabrication methods and machines that can now be applied for personal or small-batch fabrication within particular contexts. Open design, here, is seen as empowering, and as helping both users and designers to program their own devices, define operations (e.g. by creating design files), and instruct machines on how to create and manufacture artefacts (Peek et

al. 2017). Open design in HCI is fundamentally about breaking down digital-analogue boundaries when designing interactive computing systems, by switching focus from computer screens and keyboards and redirecting it towards including programmable materials and electronic-tools wrapped in open-source. In this view, open design is a general-purpose approach. This in turn implies that instead of providing clear-cut directions for technology, open design as a practice engages with an abundance of diverse technologies, each with different possibilities. Open design therefore has the potential transform pre-existing economic and social structures (Ferger et al., 2013), by radically transforming the ways in which we innovate. A new line of techno-optimistic publications in and beyond HCI have taken up the idea that digital fabrication, in particular, is furthering a "third" revolution by enabling people to not only "hack" code, but "hack" machines and, by extension, economies of scale (Gershenfeld 2012, Anderson 2012). Two elements are central to the advancement of these ideals; both the setting up of new spaces - from hackerspaces, makerspaces, coworking spaces to incubator and accelerator programs – as well as new sociotechnical infrastructure. For example, competitions and entrepreneurship training programs such as hackathons and start-up weekends have become increasingly common (Irani 2015; Lindtner 2015; Lundberg et al., 2017).

While the vision for, and the promise of, open design is free sharing for all who want to contribute and participate, we know from earlier research that open participation is not guaranteed by putting available material online (Fox, Ulgado & Rosner, 2015; Mendez et al., 2018). Diversity, inclusion, and equality for participation in technology development is a tremendous challenge for open design (Menendez-Blanco, Bjørn et al. 2018). To participate in open design activities often means gaining access to makerspaces. And while these spaces often have inclusion as an explicit goal, in reality they are often more complex to access (Taylor et al. 2016). A key risk is that only the privileged will have participatory access to open design. Diversifying open design has the potential to create various horizontal spaces, both digital and physical, while allowing for more inclusive participation and diverse forms of participation. How and indeed, whether, this can be achieved is a challenge for today.

Articles in this Special Issue

In this special issue, we are excited to present a collection of four important papers, each of which bolsters the analytical tools for understanding open design and opens up new avenues of exploration for open design as a core topic for HCI.

The first paper is a comprehensive literature review by **Bakırlıoğlu and Kohtala**, which summarises the academic literature on 'open design'. It reviews both empirical studies and conceptual papers across the fields of design and HCI, engineering and politics. The paper analyses conceptualisations of open design as 'open-source design' and 'open hardware' spanning both 'making' and 'manufacturing' contexts, as well as practices straddling these domains. The review identifies key themes including socio-environmental sustainability, new/alternative business models, ownership, and community.

The subsequent three papers present empirical studies, undertaken across a range of geographical contexts. Each paper sheds new light on open design through a particular lens. **Dew, Landwehr-Sydow, Rosner, Thayer and Jonsson** present empirical research undertaken in Stockholm, Sweden and Silicon Valley, California, and outline some of the sociotechnical

challenges to open design. In particular, they describe the complexities of 'articulation work' (Schmidt & Bannon, 1992), a practice composed of complex informal interactions between 'a diverse cast of practitioners, machines and materials'. They ask how 3D printing practitioners understand and enact the notion of 'printability', and consider ways HCI might better support the particular social factors within different ecosystems of making and manufacturing. Using a qualitative methodology, the authors reflect upon the ways that exploration and intervention factor into the different constituent processes. This leads them to call for new infrastructure to support the articulation work that plays a key role of tying these processes together.

Freeman, Bardzell and Bardzell focus on broadening of participation in IT envisioning in the context of making, open design and open manufacturing. Drawing upon a rich empirical case study of the MakerPro community in Taiwan, the authors explore how the process of collective visioning informs IT agendas within that community. The paper identifies the importance of a clear and united 'vision' in this context and highlights the challenges associated with obtaining widespread buy-in. In doing so, the paper provides key insights that will help shape a new HCI agenda around open design and open manufacturing. In particular, it analyses how a design vision is formed in this context and how collaboration, participation and democratic processes can help to overcome barriers to participation. A key insight relates to the way collective purposiveness can effectively help shape not only a design vision, but also a vision for a future national identity.

Menendez-Blanco and Bjørn discuss an important interface between the open design movement and the general public. Makerspaces have a key part to play in making both the machinery and the culture of open design available to a wider audience. They can also act as entry points into new ways of manufacturing and working. The authors study how these makerspaces represent themselves to the outside world through social media. The authors choose this analytic lens, because social media provide a channel through which many gain their first exposure to activities, while also helping existing members to sustain their engagement between visits. By analysing the social media presences of makerspaces in Copenhagen, they identify how online content supports engagement with the spaces by communicating the opportunities for participation and the parameters what constitutes legitimate participation.

Future Directions

As highlighted by these diverse perspectives, open design is in-the-making. Its associated vision/s and practice/s are currently being shaped by diverse cultures, across different domains. It will take effort to enable people to not only *use*, but also participate in the transformation of personalized and industrial manufacturing. Here, human-computer interaction research has an important role. HCI can promote new understandings of open design and generate inroads for a broader range of participants, by making technology more available and accessible. HCI can also help develop cooperative digital platforms that support participation and sustain global open design communities. Finally, HCI can help utilize the potential in open design between personalized batch production and industrial manufacturing. This special issue is just a starting point for open design endeavours in human computer interaction research but we have identified a number of critical parameters for developing our further understanding of this nascent phenomenon; in highlighting these topics, our aim is to promote future work on these topics.

Expanding Cultures of Open Design

We should be mindful that open design in densely-populated, richly-infrastructured, highly-developed tech centres might be functionally and operationally different from open design in other areas. Both the general literature on open design and the detailed case studies in this special issue reflect activities from across the developed North; from North America to mainland Asia. Notable loci of open design include established tech centres including: California and the East Coast (USA); the United Kingdom; Scandinavia; Italy; Bangalore; Shenzhen; Taiwan. We know that there are strong cultural differences *between* these loci (Lindtner et al., 2014; Bardzell et al., 2017; Irani, 2015) and even cultural differences *within* these loci (Green & Kirk, 2018), yet the fact that 'open design' unites activities across these sites suggests that open design is culturally diverse. We must therefore pay greater attention to innovation taking place in contexts of infrastructural inaccessibility such as the tech start-up scene in Palestine (Bjørn and Boulus-Rødje, 2018), while registering the wide socioeconomic differences between technology development in the Global South and in the Global North (Bjørn et al 2017). Indeed, in some parts of the world, 'open design' may exist by another name. We should therefore take care that - in our attempts to articulate coherent strands across open design - we do not miss opportunities to enrich the discourse with diverse cultural perspectives. At the present time, for example, there is little evidence that 'open design' has a foothold in areas such as Africa, Latin America, South America, the Middle East, Australia and Russia. Yet we should not presume that these regions have nothing to tell us about open design, including, potentially, perspectives that could usefully inform open design in regions where it is established and referred to by name. Future work should therefore actively explore open design in new parts of the world. This certainly includes those regions of the world that are widely under-represented in design and HCI theory, but it also includes rural areas that might be interacting with our familiar sites of interest in novel ways, or subcultures within those areas; the inclusion and accessibility agenda that is growing across HCI is one that should be embraced here as well.

Exploring Values Across Different Domains of Open Design

Open design currently spans a variety of domains that reflect different values, goals, purposes, and procedures. Research on 'making' and cultures such as the 'maker movement' inherently addresses openness and therefore aligns relatively easily with the corresponding 'openness' of open design. How open design manifests in contexts such as industrial manufacturing is less obvious, and there is relatively little research in this domain. 'Open innovation' is one visible manifestation of openness in industries, yet this is a highly contested area. Questions remain about the extent to which those participating in open innovation processes, employees and external individuals alike, may be exploited by those in positions of power. We can only speculate as to why the scientific discourse in HCI on openness in industry is under-developed. Perhaps it's because access to those - often very closed - environments are limited. Perhaps it is also because there is a lack of openness in industry and it is therefore difficult to assess the benefits that openness would contribute to innovating products, services or production processes beyond company borders. A value-centred approach to this kind of research may be needed to assess the value of openness within this domain and how questions of ethics and participation are considered in industry contexts.

Documenting New Practices of Open Design

In the workshop series that led to the developing of the call for this special issue, we explored the alignment of open design to new models of ownership, production and consumption, and discussed critical and interventionist approaches to tech production, such as commons-based peer-production and remix culture. Within these conversations, there were underlying political and philosophical threads, particularly relating to new patterns of labour and work. This suggests another possible focus for future research. The groundswell of interest in co-creation, grassroots movements, collectivism and shared ownership are often presented as being diametrically opposed to established practices of manufacturing, where concern for (private) ownership of rights and intellectual property tend to constrain the majority of design practices. To what extent is this black and white picture disrupted (or perhaps supported) by the emergence of open design? What 'shades of grey' are enabled - or suggested - by open design? And what subtleties in the parameters of ownership, labour, value and work remain under-explored and might be re-explored through the lens of open design? Future researchers might wish to unpack the relationship between open design and ideologies such as postcapitalism, socialist libertarianism, anti-imperialism and communitarianism, prompting new questions such as: how might open design contribute towards the end of wage slavery? Or how might open design support localised trade economies that minimise the transportation of goods?

NOTES

Background. This special issue is the culmination of a series of workshops dating back to 2015. The first of these, *The Future of Making: Where Industrial and Personal Fabrication Meet* (Aarhus, Denmark, Aug 2015) explored fabrication trends such as personalisation and the utopianism of the "maker" identity. The second, a three-day expert summit, *Rethinking Technology Innovation: Factories, Fabrication & Design Research* (Salzburg, Austria, Sept 2015), explored conflicting goals (e.g., democratizing technology, profit orientation) and how this relates to innovation in products, services, and processes. The third, *Fabrication & HCI: Hobbyist Making, Industrial Production, and Beyond* (CHI2016, San Jose, USA, May 2016) focused on changes in fabrication cultures, as well as how they might affect education, technologies, and HCI research. Most recently, the eponymous workshop, *Open Design at the Intersection of Making and Manufacturing* (CHI2017, Denver, USA) brought together the co-editors for the first time to explore interdisciplinary perspectives on the challenges of reconciling the democratic ideals of the maker movement and the practicalities of scalable, sustainable and reliable manufacturing.

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