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Makerspaces are subjects in a plurality of institutional advances and developments. What kinds of hybrid arrangements emerge through these encounters, and what becomes of the occupied factories for peer production theory? This special issue features 13 peer-reviewed papers that report rich, empirically-informed insights into makerspace institutionalisation and the possibilities for transformational change, and 7 alternative reflections from key practitioners in the field.

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EDITORS' INTRODUCTION: LIBERATORY TECHNOLOGIES FOR WHOM? EXPLORING A NEW GENERATION OF MAKERSPACES DEFINED BY INSTITUTIONAL ENCOUNTERS

by Kat Braybrooke, Adrian Smith

INTRODUCTION

In October 2014, issue five of the Journal of Peer Production described makerspaces (or sites for making and learning with technical tools and mentors, also referred to under many other names) as the "occupied factories of peer production theory" (Maxigas & Troxler 2014). Authors contributing to that special issue compiled a theoretically and empirically grounded analysis of member-owned spaces like shared machine shops, hacklabs, hackerspaces, fablabs and makerspaces — spaces that appeared to signal a revolution for new commons-based, peer-produced modes of design and manufacturing. On closer inspection, however, the contributors found a variety of tensions and contradictions amidst the exciting possibilities. Whilst some practices anticipated democratic transformations in making and remaking things in society, other practices appeared to be epiphenomenon for neoliberal business-as-usual, such as the exploitation of precarious creative labour by various business and government institutions.

Three years later, the darker side of makerspaces burst into flames. On the night of 21st November 2017, a group that others labelled anarchists burnt down Fablab La Casemate in Grenoble, France. Fortunately, no one was hurt. The communication by the perpetrators stated that hacker notions of liberation through technology were illusory, and that no matter what the utopian aspirations, makerspaces were irredeemably and inseparably part of a hegemonic technological society. To the saboteurs, the popularisation of digital fabrication and culture in La Casemate connected directly to the oppression of dominant social institutions, and they had to be challenged. In an echo of the anti-automation protests of late 1970s France levelled on computer companies by the Committee for Liquidation of Subversion of Computers (CLODO) who described the computer as a tool of repression, the sabotage assaulted mainstreamed notions of social progress through technology.

Like others, we were shocked by this act. Even if such violence were ever justified, which is debatable, there are many more obviously oppressive technology installations ripe for sabotage and critique. The trouble with violence is that a deplorable medium inevitably does a disservice to its message. Whilst the violence itself must be condemned, its underlying challenge nevertheless warrants further examination. Today's makerspaces need to reflect upon how, precisely, they provide progressive social possibilities. Hope in such possibilities are held by many, including us – but where is the proof? Who is liberated by the liberation, and who is not?

Technology is never neutral, as the saboteurs remind us in their communique; but neither should digital technologies be viewed as hard-wired and deterministic (Matthewman 2011). Technologies embody and advance ever-evolving constellations of social values, choices and power geometries. Technologies are adaptable, depending upon the

situations in which they are produced and put to work. Technologies form part of dominant sociotechnical regimes which can be both hegemonic and hackable, and whose trajectories of development can be opened up and altered. The experience of using, say, a router in a community-project dedicated to the participatory provision of street-furniture that reclaims a public space, is quite different to that of machining for one's boss in a factory, where the operative has no control and is alienated from the flat-pack furniture being sold. The sociotechnical configurations are different. The significance of the technological element employed within these configurations is different. The social relationships tied together and mediated by the technologies are different. The value created and distributed is different. Makerspaces enable such sociotechnical experimentation. But is the experimentation not as open, inclusive and progressive as many of us had assumed?

BACKGROUND TO THIS SPECIAL ISSUE

These were the questions raised in a conference track in September 2016 that became the genesis of this special issue. The track – *Whose 'liberatory technologies'? Digital fabrications amongst hackers, makers and manufacturers* – was organised by Adrian Smith, maxigas and Johan Söderberg as part of the 'Science and Technology by Other Means' conference held in Barcelona by the Society for Social Studies of Science and the European Association for the Study of Science and Technology. Revised versions of some of the track's contributing papers feature in this special issue.

The conference track began by noting the fact that many of the digital design and fabrication technologies promoted in makerspaces hold particular historical ironies and contradictions: for example, the early introduction of computer-numerical-controlled machining (CNC), computer-aided-design (CAD), and computer-integrated-manufacturing (CIM) threatened skills, livelihoods and identities amongst manufacturing communities in Europe and North America in the 1970s and 1980s (Noble 1984), even as their more accessible technological descendants are celebrated today for enabling new kinds of agency, learning and communities for makers (Gauntlett 2013).

Can the technology of digital design and fabrication really escape their origins in earlier waves of manufacturing as automation? Just how open to radical sociotechnical reconfiguration are they? Whilst primitive anarchists like John Zerzan might argue that any historical turnaround in the significance of automating technologies is a mirage, and that activity today is still based in an inherently technological (and therefore oppressive) society, social anarchists like Murray Bookchin might be more hopeful and enthusiastic regarding their alternative technological possibilities. Fifty years ago, Bookchin, like other activists, welcomed a post-scarcity future in which technological progress would give collectives the opportunity to own tools and organise production non-hierarchically and sustainably, harnessing 'liberatory technologies' for socially useful purposes (Bookchin 1967). In this view, as Janet Biehl (2007) has written, the onset of technological innovation would not merely lead to embourgeouisement and complacency, but would instead provide everyone the freedom to build a more cooperative society.

In a different setting, organized workers in Scandinavia and other countries worked with leftist researchers in the 1980s for the introduction of human-centred computer technologies into workplaces, and in ways that would democratize the labour process. Whilst they failed to convince owners and management, in pursuing a different sociotechnical pathway, they did pioneer methods in participatory technology design (Ehn 1988; Asaro 2000; Smith 2014). Do the grassroots appropriations built today in hackerspaces and makerspaces and in open hardware groups on the web mean we are closer to this democratic, tool-based creativity? Or does the design entrepreneurship also practiced in makerspaces merely feed into (and actually reinforce) the ongoing automation and alienation of manufacturing as digital progress? The debates

about the action at La Casemate, including the conflicting views of different anarchist groups, perpetuates a long-running and ongoing concern.

Contributors to the conference track found the posing of binary questions like those above to be of limited help, even though the issues raised are important (for a track report, see Boeva & Chies 2017). Their contributions also highlighted the increased importance of institutions in shaping both makerspace possibilities and limitations, and influencing how issues of oppression and liberation play out in practice. Looking at institutions means suspending, at least initially, broader hegemonic/counter-hegemonic characterisations, and not overloading situations with revolutionary expectations. Whilst radical characterisations and criticisms remain helpful in situating makerspace practices within a wider conceptualisation of power in society, they risk rushing too quickly to a definitive evaluation of heterogeneous activity: oppressive or liberatory; captured or transformational; 0 or 1? Such definitiveness risks overlooking more nuanced possibilities. After all, as Stuart Hall, Doreen Massey and Michael Rustin have reminded us, reframing a society's norms requires the right conjunctural moment, a 'ruptured unity' (2013, p. 12) where many different political, cultural and economic actors converge to produce a different settlement (2013).

Situating the dynamics of makerspaces within more textured relationships with prevailing social institutions, and viewing such relations as more open-ended and susceptible to change, permits a finer-grained appreciation of makerspace possibilities and limitations. The plural relationships between makerspaces and institutions seemed, to us, one way to approach the task of power and politics in makerspaces that unpacks the binary questions above. Social institutions influence the emergence of sociotechnical configurations in societies; they help stabilise some configurations and underpin their development into dominant 'sociotechnical regimes' (Fuenfschilling & Truffer 2014). Dissatisfaction with such regimes and criticisms of institutional influence can prompt the creation of alternative sociotechnical configurations. Makerspaces are simultaneously autonomous spaces where experimental configurations arise, and spaces where conformity and isomorphism with and between institutions takes place. The plurality of these relationships with and against institutions do not fall neatly into either/or categorisations: oppression versus liberation; capture versus autonomy; business-as-usual versus fabrication-as-democracy.

Seen in this light, questions can be reformulated in a more open-ended manner: how are makerspaces encountering institutions in practice, and how are makerspaces institutionalising their practices? How are autonomous spaces maintained beyond the designs that different institutions may have? How are practices reinvigorated or altered in response to these encounters? Throughout the editorial process, we left what was meant by 'institution' deliberately open – though we did encourage contributors to be explicit in how they understood and approached institutions in makerspaces. The result, we're pleased to say, is 13 papers that report rich, empirically-informed insights into makerspace institutionalisation and the possibilities for transformational change, along with six alternative reflections put together by key practitioners in the field.

INSTITUTIONAL ENCOUNTERS

Institutional theory seeks to explain the settled social environments in which organisations operate and the consequences those environments have for organisational development. W. Richard Scott defines institutions as those, 'cognitive, normative, and regulative structures and activities that provide stability and meaning to social activities' (Scott 1995: 33). Douglass C. North provides another highly cited definition that is broadly similar: 'Institutions are rules, enforcement characteristics of rules, and norms of behavior that structure repeated human interaction' (North 1989: 1321). Institutions can be very broad and cultural, such as those

concerning property, and tied to bodies of theory, like the neo-classical economics that were a focus for North; or institutions can be specific and instrumental, such as a particular regulation, the work of a government agency, or the formation of a law.

Whilst institutions constitute a powerful pressure for conformity – such that organisations often start to resemble one another (Di Maggio & Powell 1983) – there is nevertheless scope for strategic manoeuvres by organisations encountering these pressures. Depending upon circumstances, and the resources available to an organization, strategies can variously involve acquiescence, compromise, avoidance, defiance, or manipulation of institutions (Oliver 2018). Institutional environments can also be complex, consisting of multiple institutional logics whose (conflicting) demands can be played off one against the other and negotiated (Pache & Santos 2013).

Criticisms of institutional theory cast it as overly static and conservative (Munir 2015), prompting perspectives that view institutions more dynamically, and that propose approaches interested in the creation of new institutions that transform social environments through organizational agency and shifts in the power relations that otherwise maintain institutions (Hirsch & Lounsbury 2015; Suddaby 2015; Fuenfschilling & Truffer 2014). Institutional entrepreneurs can work to reform or transform institutions, for example, by exploiting social movements and shifts in social discourse, and that undermine the legitimacy of incumbent institutions and open space for the development of alternatives (Zietsma & Lawrence 2010; Levy & Scully 2007). Despite this, doubts linger about the critical and emancipatory potential of institutional theory and practice. By definition, institutions seek to normalize and routinize and, when challenged, tend to adapt and elaborate rather than transform and liberate (Willmott 2014).

These themes will be familiar to observers and participants of makerspaces. Makerspaces have caught the imaginations of a wide variety of people and organisations coming from different settings, inspiring institutional actors to see an exciting buzz of organized possibilities. Depending upon the specific institutional encounter, makerspaces are becoming cradles for entrepreneurship, innovators in education, nodes in open hardware networks, studios for digital artistry, ciphers for social change, prototyping shops for manufacturers, remanufacturing hubs in circular economies, twenty-first century libraries, emblematic anticipations of commons-based, peer-produced post-capitalism, workshops for hacking technology and its politics, laboratories for smart urbanism, galleries for hands-on explorations in material culture, and so on and so on … and not forgetting, of course, spaces for simply having fun.

Sometimes institutional interest derives from the possibility makerspaces present in delivering longstanding agendas in novel ways, promising a reinvigoration of the norms and routines by which that agenda is realised. An example here might be makerspaces providing an engaging, hands-on way to educate youngsters in the institutions of mainstream science and technology (e.g. using scientific methods, formalising bodies of knowledge, and reinforcing the significance and standing of science in society). In other cases, makerspaces attract interest because they anticipate new institutional possibilities. An example here could be new norms for manufacturing in open and circular ways. Often, as we see in the contributions to this special issue, there are complex mixes of both these currents: existing institutional agendas moving in, and new institutional possibilities emerging out of these sites of experimentation.

So, makerspaces are subjects in a plurality of institutional advances and developments. There are pressures to conform (sometimes willingly, for example when institutional encounters bring welcome opportunities for securing resources, stability and status). But makerspaces simultaneously remain a source of variety, generating narratives and practices ripe for

institutional entrepreneurship and transformational possibility. But isn't there a contradiction at the heart of these encounters? Makerspaces are about experimentation, improvisation, and unruliness. Institutions promote regularity, certainty, and orderliness. Does this mean institutional encounters in makerspaces will inevitably and ultimately prove unstable? What kinds of hybrid arrangements are negotiated and emerge through these encounters? How do makerspaces maintain autonomy such that they can deal with institutions on their own terms? What happens to spaces for diversity, contrariness, and alternatives, and where do they go, as some activity routinises and normalises and perhaps comes to dominate? What becomes of the occupied factories for peer production theory? And of course, how does power get reconstituted and manifest in these encounters?

PEER-REVIEWED PAPERS

The 13 peer-reviewed research papers that make up this special issue deal with different aspects of these institutional conundrums. Some papers are about institutional entrepreneurship and the institutionalisation of new practices originating in makerspaces. Other papers examine what happens when existing institutions enter into makerspaces. And many papers look at both these directions of travel. In "Institutionalisation and informal innovation in South African Maker communities", Chris Armstrong, Jeremy de Beer, Erika Kraemer-Mbula and Meika Ellis look into the co-existence of informal and institutional practices in makerspaces in South Africa. Institutionalisation, here, emerges through a variety of strategies, including the formalisation of maker community practices, partnerships with formal organisations, and embedding makerspaces in formal organisations. Whilst their evidence points to considerable institutionalisation, they find that even in these more formal situations a commitment to informality is valued, such as working imaginatively in open collaboration with innovative projects, where knowledge appropriation is handled informally. Makerspaces are thus seen as playing a helpful intermediary role in bridging the more formal development of innovation systems with the large informal sectors of South African society.

The ability of institutions to connect beneficially with large informal sectors is a theme in "Making in Brazil: Can we make it work for social inclusion?" by Rafael Días and Adrian Smith. They write about an initiative by the city authorities in São Paolo that opened public FabLabs in different districts, including the disadvantaged Cidade Tiradentes on the margins of the city (literally and figuratively). They discuss the initiative, and its aspirations to seed inclusive developments in the community. These hopes are situated in the Brazilian culture of improvisation and making-do known as *gambiarra*, and earlier programmes for social technology aimed at emancipating people from poverty through other participatory technology programmes. What is striking in this case, and familiar to public support for makerspaces in other cities, is how makerspaces are seen as an instrument that follows a 'script' for development as seen by those institutions, sometimes to the puzzlement of the intended beneficiaries. What will be important in the São Paolo initiative, and others, is the processes by which people can bring their own scripts into technology developments in makerspaces and narratives about the communities in which they are situated and what they'd like those communities to become.

The importance of permitting a diversity of scripts to enter into technology and making becomes especially apparent in the study of makerspaces in Nairobi undertaken by Alev Coban in "Making hardware in Nairobi: Between revolutionary practices and restricting imaginations". Adopting a conceptual approach of performativity, her ethnography shows how institutional presumptions about 'African' development and poverty informed a particular, and questionable, view of social impact for makerspaces. She argues this reinforces (post-colonial) power relations with regards to what kinds of technology project were worthy of support and promotion, and which not. Perversely, good

intentions – materializing in the funding of technology with social impact – end up further performing an exoticized take on poverty, rather than opening up to the wealth of ideas and diversity of talent that exists in Kenya.

Differences in institutional designs upon makerspaces is illustrated in a different way by the comparisons Pip Shea and Xin Gu make between FabLabs in two nations with "Makerspaces and urban ideology: The institutional shaping of Fab Labs in China and Northern Ireland". The provision of open spaces and networks that support participants to do creative things with technology in collaborative projects is supported for differing instrumental purposes by public authorities. In China, they argue makerspaces are viewed as a practical way of promoting innovation culture, entrepreneurialism and a government-led economic agenda, whereas in Northern Ireland value is seen in the ability of making projects to build bridges between communities that carry a history of conflict. Rather than makerspaces rolling-out a universalist commons-based peer-production 'paradigm', spaces are found to be shaped more significantly by local and regional cultural values and expectations, reflected in the availability (or lack thereof) of institutional priorities and support.

Nevertheless, many of the leading figures of makerspaces are motivated by commons-based, peer-production possibilities, even if the practicalities of running a site and working with supportive institutions to keep it open means falling short of this ideal. In "The sociomateriality of FabLabs: Configurations of a printing service or counter-context?", Cindy Kohtala draws upon ethnographic fieldwork to examine conflicting sociomaterialities at FabLabs in Europe, in doing so analysing how a tenuous co-existence between alternative and mainstream values can be negotiated through specific social and material practices. Her paper discusses how the commodification and conformity of some FabLab practices is entangled with the negotiated reconstitutions and aspirations of a more counter-cultural current of activity. This is illustrated by looking at the dynamics evident in specific kinds of work, knowledge and imaginative objects.

Commitments to common-based peer-production can, of course, constitute an informal institution in itself, to the extent that a set of norms and routines are established through such commitment. Compared to the backing by states and corporations for other kinds of institutions, such as those reinforcing market-oriented innovation and entrepreneurship, the informal norms of commoning and working as peers can seem at a disadvantage. Nevertheless, aspects of practices informed by commons-based peer-production can attract institutional entrepreneurs, who see a chance to win support for their activities by aligning with higher-level policy agendas. In "The institutionalization of making: The entrepreneurship of sociomaterialities that matters", Evelyne Lhoste and Marc Barbier look at these dynamics in their history of FabLab developments in France. They explore how notions of innovation and entrepreneurship enable a host of different agents, artefacts and organisations to assemble around and find value in makerspace practices, and the important intermediary role FabLab managers play in the institutionalisation of these practices from a uniquely French perspective, including those at La Casemate in Grenoble.

In "Can one size fit one? A prospect for humane custom production", ginger coons provides some useful historical perspective on the excitement for personalised production that emanates from today's makerspaces, and particularly the increasingly accessible digital fabrication technologies facilitated by these sites. A comparison is drawn with dress-making practices in the 18th and 19th century, and the increasing access to patterns, sewing machines, and possibilities for personalised clothing. In taking the longer view, mass-personalisation today, in which customers can tweak patterns, is seen as an attenuation of the possibilities for much freer user relations with making. Coons argues institutional orientations towards smaller-scale production (as compared to mass-personalisation) would, from a

historical perspective, have a better chance of genuinely involving the user in a more humane form of manufacturing.

Coon's argument is perhaps reinforced by "In situ, 3D printed heritage souvenirs: Challenging conventional spaces and culture", Sam Vitesse and Constantia Anastasiadou's report on the use of on-demand 3D printed souvenirs at a gift shop at Stirling Castle in Scotland. A 'pop-up makerspace' was set up near the castle's gift shop, where customers could choose from a range of designs and materials, and thus create a somewhat personalised memento of their visit to the castle. Vitesse and Anastasiadou look at the implications of this arrangement for material culture, situating the gift shop as an institution oriented not just around sales, but also around materially enduring relationships between visitor and official heritage attraction. Emotionally enduring design is advocated by some as a way of promoting a more sustainable material culture, precisely by making 'made' objects more meaningful to owners and users (Chapman 2009). So whilst a 3D print in a gift shop might appear particularly niche and innocuous, it nevertheless points to the bigger themes of sustainability covered by Cindy Kohtala.

In exploring political economies of the heritage sector in Britain, Kat Braybrooke's research in "Hacking the museum? Practices and power geometries at collections makerspaces in London" considers how 'collections makerspaces' have been used by cultural institutions to create new experiences and hence relationships between artifacts, culture and visitor experience. She has studied their use through an applied, multi-site ethnography of three museums in London – Tate, the British Museum and the Wellcome Collection – and focuses on the geometries of power that are revealed through user practices and interactions at these emergent spaces. Starting with a genealogy of makerspaces that is framed around four temporal waves of innovation, she argues that as recent initiates into an institutionally-oriented fourth wave of spatial interactivity, collections makerspaces may be activated by their users in ways that facilitate critical inquiry into museums themselves, and the conventions of culture and privilege they represent. Power geometries do not disappear, but they do morph and evolve, and can result in a redistribution of power balances through peer production practices, in doing so changing notions of what a museum should and can be.

Redistribution is also the focus of the paper "Redistributed manufacturing and makerspaces: Critical perspectives on the co-institutionalisation of practice" by Liz Corbin and Hannah Stewart – but here, the important relationships occur on a macro-level. They consider how makerspaces are cast in the broader technical possibilities for manipulating the global circulation of design and machining instructions to local fabrication and production. The concept of redistributed manufacturing (RDM) has become alluring for a number of institutional agendas, all of which look to makerspaces as pioneers, prototyping systems and practices that enable revolutionary ways-of-doing. By looking into the tensions and contradictions of RDM discourse, and its dismissal of certain techniques, tools and materials while others are championed, Corbin and Stewart explore the increased importance of external agendas to the governance, purpose and focus of peer production communities. In doing so, they are able to peer beneath the peer production 'technomyth' (Braybrooke and Jordan 2017) itself.

Intriguingly, instrumental uses of local production capacity connected to cosmopolitan and mobile design possibilities is the point of departure for a quite different study in "Achieving grassroots innovation through multi-lateral collaborations: Evidence from the field" by Silvia Buitrago Guzmán and Pedro Reynolds-Cuéllar. Here the site of inquiry shifts to Colombia, and the use of citizen innovation events and temporary makerspaces as an instrument for development and peace-building. After a helpful review of issues in development collaboration in technology, the authors provide analysis and reflection of two international design summits convened in Colombia in which they

participated. The summits were intended to catalyze and support local innovation capabilities and peer production. Whilst they succeeding in making visible a rich variety of creative possibilities, the events also made apparent the lack of institutions available to help foster the further development of promising activities after the events. The challenge, here, is creating local institutions that bring universities, international organisations, civil society organisations, and business investment to the service of grassroots initiatives. Sustaining the success of these events requires an appropriate institutional environment.

In "Configuring the independent developer", Tobias Drewlani and David Seibt examine a quite different instrumental use of the possibilities of making-as-peer production when it is harnessed by an influential multinational corporation. They examine the roles played by the 'independent developer' in a work programme organized by Google for the development of a modular smartphone. To build the phone, Google tried to maximize on the potentials of voluntary labour by bringing together a community of (unpaid) technology enthusiasts in the process of creative development – something which open hardware networks are doing in all sorts of domains. Grassroots enthusiasm and the apparent openness of Google were only able to mask the underlying tensions for so long before the project collapsed under the weight of its own contradictions. Drewlani and Seibt argue the experience is typical of current attempts by large firms to engage grassroots production communities in digital fabrication.

Our final research paper, "ReMantle and Make: A cross geographical study exploring the role of makerspaces and the circular economy in Scottish textiles", is written by Paul Smith, Michael Johnson and Lynn-Sayers McHattie. They report on a design study centred on a workshop where makerspace practices are used to explore circular economies for the textile industry at two geographically different sites in Scotland. Issues in making textile production and the circular economy were situated around activities that were embodied in the hands-on making of textile products themselves using off-cuts and scraps. In a similar vein to other studies of this issue that looked at the use of the makerspace as an instrument of collaborative exploration, Smith, Johnson and McHattie find a disconnect between the successful raising of issues and the cooperation of institutions capable of carrying proposals to action, revealing a foreshortening of the makerspace-as-transformational possibility. Nevertheless, they conclude there is a usefulness in the kind of democratic knowledge production that is enabled by these interactions.

PRACTITIONER REFLECTIONS

In additionally inviting more experimental pieces from practitioners as part of this special issue, we hoped to broaden the diversity of perspectives by sharing not only academic research but also on-site reflections about the effects of institutional engagements in these spaces. We were happily impressed by the diversity of knowledge and inquiry shared by those who participated.

Robert Richter and Daniel Wessolek share their reflections on the different traditions of fabrication and making that define the Futurium and the Museum für Naturkunde in Berlin, two institutions that target a similar audience. Artist and Tate Digital Studio Producer Luca M Damiani experiments with new communication formats to illustrate the tensions and opportunities offered by the convergence of art and technology across formal and informal maker settings. Molly Rubenstein, Benjamin Linder and Kofi Taha from the MIT-D-Lab provide valuable lessons from their engagement with the Artisan's Asylum in the United States, noting the distorting effects of financial support on grassroots initiatives, comparing its model to that of the much better-resourced International Development Innovation Network (IDIN). Kazutoshi Tsuda, Mitsuhito Ando, Kazuhiro Jo and Takayuki Ito from the Yamaguchi Centre for Arts and Media (YCAM) in Japan discuss the gradual expansion of its lab and fabrication spaces over the past 30 years of the centre's development, noting the beneficial

possibilities offered by a public institution which allows itself to evolve with the times. The Centre for Sustainable Design's Director Martin Charter, meanwhile, reflects on the emerging consciousness of a 'fixer movement' in the United Kingdom, from repair cafes to other local community efforts aimed at reframing consumer culture. Em O'Sullivan shares photos from her research into issues of accessibility and diversity in the maker movement, highlighting the efforts of a series of inclusivity-focused makerspaces in the United States and the United Kingdom that aim to address these challenges.

We also directly participated in the process of institutional collaboration ourselves for this special issue. Invited to share our findings with a new kind of audience at Tate Modern, we collaborated with Tate Digital Learning to curate a mini-exhibit as part of Art:Work, which we describe in "Space Gather Make: Shared Machine Shop Sound". By asking what worker-owned labour looked and sounded like at the makerspaces featured in this special issue, the sites of this issue's practitioners were envisioned as a series of distinct visual environments, each imbued with its own kind of life. We collaborated with sound artist Vasilis Moschas, who created a conceptual audio installation that explored the sound environments of each site, illustrating typical on-site experiences of flow, discontinuity, repair and breakdown.

CONCLUDING THOUGHTS, NEW POSSIBILITIES AND THE DEVILS IN THE DETAILS

So, what have we learned in coordinating this special issue of Journal of Peer Production in its many facets? And how might those lessons inform responses to the kind of violence witnessed at La Casemate? Our initial response was to suggest makerspaces are sites of ongoing sociotechnical experimentation. The contributions confirm and elaborate on this point. Critics of makerspaces, meanwhile, seem to flip back and forth between sociologically and technologically deterministic views. Technologically deterministic in the sense that the digital fabrication equipment in these sites is considered to be inherently oppressive towards people, and therefore has to be challenged. But at the same time technologies are seen as the tools of capital, whose interests develop and underpin their oppression. Under this sociologically deterministic view, challenging oppressive instruments constitutes an attack on repressive social arrangements.

What unites the case studies, analyses and arguments of this special issue is their call for more flexibility. Alternative sociotechnical arrangements illustrate how some technologies can be subverted, and hegemonic forces countered. Promising sociotechnical openings are found, for example, in the way making can cultivate and express talents and knowledges previously overlooked by institutions and enable their recognition; or in the way making can prompt reflections about our material culture and generate practices for more sustainable cultures; or in the way making can remind us of life beyond that of 'rational' economic man (and it is all too often a man) and the diversity of motivations, conditions and moments of activation under which radical creativity and collaboration emerges. There is plenty of scope in all this activity for informing and influencing progressive institutional reforms.

However, all of the contributions to this special issue also have a critical edge. The institutional agents who direct what gets selected, institutionalized and turned into development pathways beyond the walls of makerspaces do not constitute a wide-open frontier where everyone is welcome. Some paths are easier than others and made more available to some groups than others. Recalling Issue 5 of Journal of Peer Production, whilst peer prototyping is still evident, actual peer production remains challenging. We note how even peer prototyping in makerspaces is structured by institutional biases and has to be proactively countered – see, for example, Issue 8 of Journal of Peer Production on feminism and (un)hacking. The point, however, is that it *can* be countered. We find this in the contributions to this

special issue also, where progressive possibilities are being opened up, and renewed demands articulated to more radical institutional changes; in response to a moment when spaces for radical experimentation in peer production are being closed down, whether due to their capture by institutions, or because experience with the existing institutional landscape teaches us that alternatives are harder to progress than initially anticipated and need a redoubling of effort.

The uneasy co-existence between makerspaces and institutions feeds into the cycle of sociotechnical experimentation reflected here. Actors – and not always the same actors – will continually seek alternatives, such as commons-based peer production. Institutions will continue to be drawn to elements of what emerges through this experimentation, and support the practice and development of those elements. What gets overlooked and left behind by these developments will disappoint those of us with alternative visions. We see this in the plurality of viewpoints around many of the practices outlined by this issue. What an institution thought would be an ambitious experimental encounter is consequently seen as missing the original point, or not going far enough. This mix of successes and disappointments galvanises renewed attempts in more ambitious experimentation, hopefully having learnt from prior experiences.

However, if this dynamic is the basic lesson we take from the special issue ('we' being its editors), then it is one that has to be treated with caution. Whilst many makerspace managers and users might be motivated by commons-based peer-production, the diversity of settings studied in the contributing papers demonstrate it need not be shared on the ground, nor is it necessarily shared by other cultures. Other purposes come into play, and these play out through specific conjunctions of institutions and grassroots actors in their localities. Advancing commons-based peer-production means ultimately viewing and adapting its ideals *through a local lens*. For all the prospects of nearly instantaneous design and fabrication, file sharing and online collaboration, making must matter locally. While this issue does display broad patterns, its cases more importantly illustrate a diverse kaleidoscope of local histories and geographies that set the important details.

Such details are important, since they can be the source of contingencies in technology development and use, the cultivation of which opens up alternatives that can be emulated and mobilised elsewhere. These contingent spaces are where categorical statements about technology can be countered – and also where the isomorphism of institutions can be undermined and unsettled. Referring to the movement for socially useful production in the late 1970s and early 1980s, which in London opened a series of community prototyping workshops that anticipated today's makerspaces (Smith 2014), sociologist Donald Mackenzie noted, "Whatever the eventual success or failure of these efforts to alter the nature of technology, our understanding of how technology changes can only profit from them. For, by making contingency and choice actual rather than merely hypothetical, they throw into ever-sharper light the ways in which social relations shape technical development" (Mackenzie 1984, p. 502).

Makerspaces, we have argued, are an obvious site where such choices and contingencies can be cultivated through local differences. Mackenzie is careful to write that experimental alternatives cast the social relations of technologies in ever-sharper light. He does not assume that improved insight into those relations automatically leads to greater agency over their transformation. But choices and contingencies arise on the institutional side of encounters with makerspaces also: the museum hacking the material cultures they curate; the education programme reforming its pedagogy; the development agency nurturing grassroots innovation; the businesses seeking new sources of profitable creativity; civil society networks building material expressions of their social values. Makerspaces help provide these institutions with new possibilities. Such contingencies and choices

open up space for new institutional arrangements. Makerspaces do not only open up the technological black box, as Mackenzie would see it, but they also can help open up institutions to social scrutiny and to a better understanding of how institutional changes reshape the prospects of different sociotechnical configurations.

Of course, many of the contributions in this special issue note the relatively limited ways in which institutional change happens. Education might become more stimulating, problem-based, and hands-on, but its openness can still be limited by deeper institutional requirements to build entrepreneurial subjects fit for labour markets. Museum collections might now be reconceived as an active dialogue, but their contents are still set by institutions that determine what is worth curating. And, for all the buzz around open manufacturing, the labour process still privileges capitalist institutions. Institutions are, after all, conservative. By definition, their norms and routines modulate and dampen developments.

These features, however, are brought into a critical light when we scrutinize what it is that limits makerspace practices from reaching more radical peer production possibilities. It becomes evident what deeper institutional changes are needed before social values committed to sustainable development, dignified work, and social justice can really become normal, routine ways to go about making things. Digital fabrication through mass manufacture of flat-pack furniture is still more prevalent than the commons-based, community fabrication of street furniture noted earlier. Makerspaces can help open up institutions, whether they are found in public spaces or homes, and they can inform the design of radical new institutions, but the power to implement those radical new norms and routines requires agency. The social value in makerspaces lies in their articulation of institutional tensions through practical activity, and in some cases, critical reflexivity – but they alone cannot shift such a powerful tide. Transformational projects arise out of the actions of many actors over time. We should not devalue makerspaces simply because they lack the agency to overturn institutional logics all by themselves.

ACKNOWLEDGEMENTS

The editors would like to give a special thanks to the many people who worked behind-the-scenes for almost two years to help them bring this special issue to life. From the issue's 17 contributing authors who helped craft the initial vision from its grassroots beginnings at 4S/EASST in Barcelona, to the 7 practitioners who joined for the ride and helped bring together the Space/Gather/Make exhibit at Tate Exchange, to the Tate Digital Learning team for inviting this issue to join them for an inspiring week of Art:Work interventions, to the 30 reviewers who spent many hours of their time providing authors with thoughtful critiques while dealing with the many intricacies of the open review process, to the Journal of Peer Production Editorial team for their essential support and guidance throughout the entire process, and Rebecca Kerr and Marion Clarke on the uploading team. Our capacity to coordinate this process was helped with support from two research projects: The Knowledge Politics of Smart Urbanism, funded by ORA-ERSC (grant reference ES/N018907/1); and the Norwegian Research Council funded project, Responsible Innovation and Happiness: A New Approach to ICTs (grant ES544769).

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PROTOTYPING THE FUTURE, REVIVING THE PAST: OBSERVATIONS OF TWO MUSEUMS AND THEIR SHARED WORKSHOP APPROACHES IN THE MAKING

by Robert Richter & Daniel Wessolek

The brand-new *Futurium* and the well-established *Museum für Naturkunde* (Natural History Museum) are both situated in the center of Berlin and target a similar audience. The *Museum für Naturkunde*, a research museum, houses a scientific collection of approximately 30 million physical objects, and a similar amount of digital assets. A current goal is to make this data treasure accessible to the public in a structured way. The objective of the Futurium Lab, situated within the newly built Futurium, is to create tangible objects and to prototype imaginative artifacts for desirable futures, while empowering visitors through skill learning and knowledge about processes in participatory sessions. Within the *Museum für Naturkunde*, computer numerical controlled (CNC) machinery is seen as a way to make these digital artifacts approachable not only in a virtual way.

Fig 1. Virtual Reality installation at the wall of biodiversity in the Museum für Naturkunde Berlin.

While one of the two institutions focuses on the history of life on this planet, the other is committed to the exploration of future living and production. Or in other words: While one museum describes how we got here, the other explores how we can stay. Of course these two approaches are necessarily intertwined. However, establishing machine shops or fabrication laboratories within larger institutions, specifically in museums, is a major challenge, as planning and processes are embedded in frameworks not necessarily designed for fluid and ad-hoc tinkering. Ideally one would be able to predict and plan machine and material needs well in advance, but as one can imagine, the process of finding the right combination of tools and materials for a specific use-case is an iterative process requiring constant trial and error. Adapting processes common in the maker culture to the special requirements inherent in these large institutions requires learning from both sides.

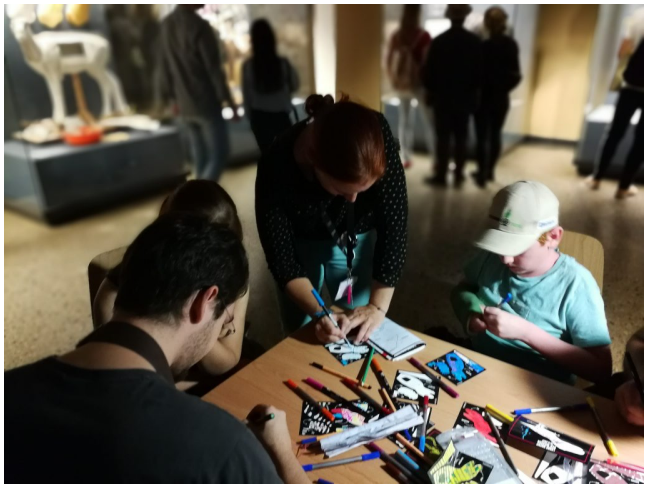

Fig 2. Visitors colouring a 2D map of a T.Rex that later gets converted in a 3D model (Museum für Naturkunde Berlin).

Though expensive, it is relatively easy to superficially recreate all key features of a makerspace by buying equipment. However, the value of a functioning "Fablab" clearly lies in the community that it harbours. It is essential for a functioning laboratory, that research and development are an integral part of the daily practice in order to inspire visitors and foster the interest in skill learning and application thereof. A culture of free-minded innovation can only be nurtured when accessibility, collaboration and decision making channels are as barrier free as possible. This also includes accessibility to the space and the machines with respect to opening hours, and a pragmatic (legal) framework for usage. Any larger institution planning to establish a shared workshop is therefore advised to critically question whether its rules and existing structures allow for the mentioned community building or if it is willing to change if necessary.

Fig 3. Maker Communities: Brainstorming meet-up with users/makers on sensory augmentation

Despite these challenges, the openness of current institutions to accommodate a culture of making and open innovation is helpful for reaching out to new and potentially larger audiences and promoting maker culture in general. There is also special potential of institutional-backed labs which do not depend on charging for machining minutes in the same way as a commercial entity would need to. Through combining machining infrastructure and knowledge sharing about making with the underlying goals of informing about the past in new ways and empowering people for futures to come are in itself signs that maker culture positively influences society in its core and that decision makers are clearly aware of the underlying potentials.

Fig 4. A Macaw on a plate (replacing the meat in a traditional German meal) representing the link between endangered Macaw populations and industrial meat production.

Disclaimer: The opinions expressed in this article are those of the authors, and they do not reflect in any way those of the institutions to which they are affiliated.

ABOUT THE AUTHORS

Robert Richter studied physics at the *Technische Universität Berlin* (*TUB*) from 2003 to 2009. Since 2006 he taught various laboratory courses and in 2013 became the head of the *Projektlabor Physik*, an innovative project based undergraduate physics laboratory course. He held this position till 2015 when he completed his PhD on the photoluminescence of Nanodiamonds.

In 2016 he was asked to establish and lead the *Media Sphere Lab* at the *Museum für Naturkunde Berlin* (Natural History Museum Berlin). As chief scientist he overvied the collaboration between the museum and startups.

He currently teaches science communication courses at *TUB* and his research is focused on maker culture, DIY Science and science communication.

Daniel Wessolek is interested in assistive design and aims to combine personal fabrication and co-design processes to solve everyday marginalized problems. Previously he has been a postdoctoral research fellow at Singapore University for Technology and Design (SUTD). In 2016 he defended his PhD in Art and Design on “Simple Displays” at Bauhaus University Weimar, where he also worked as a research associate in Interaction Design. He also holds an MFA in Media Art & Design from Bauhaus University Weimar, an MA in Art Theory from Tongji University Shanghai and a BA in Digital Media from University of the Arts Bremen.

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MAKE SPACE PROD

by Luca M Damiani

/* Make Space Prod
My
Personal
Key
Questions */

MAKE SPACE PROD

We constantly see art and technology intertwined in digital art, net-art, creative coding and current dialogues within visual culture and maker spaces. This is done through a combination of diverse artistic practices and collaborative approaches, sharing different voices about soci-ety in diverse settings, studios and spaces.

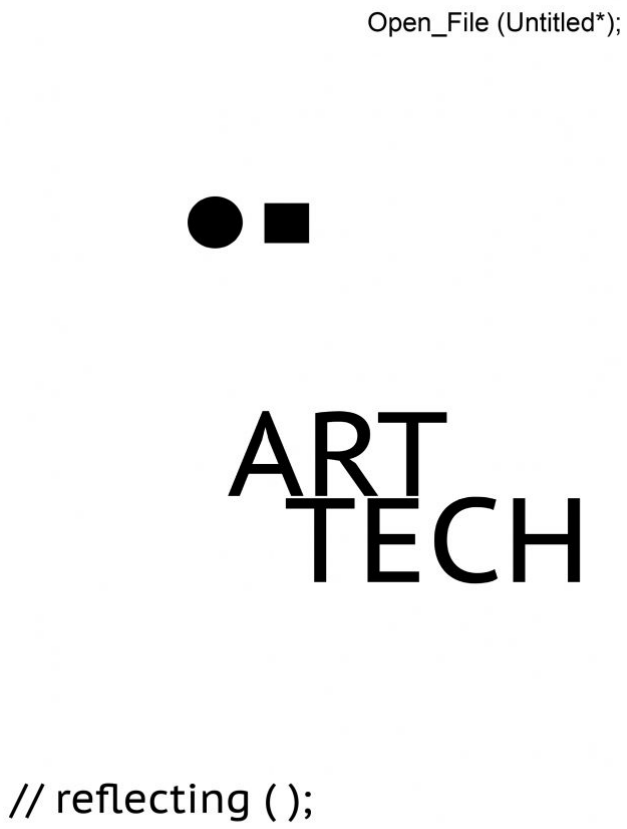
Experimenting, designing, prototyping, creating new digital artworks is to be seen daily in maker-labs and tech-studios. In formal settings this has a flow of university and/or product design development for example, but in informal settings the making becomes a part of cul – ture for balancing our consumer/producer identity. It becomes a matter of do-it-yourself cul-ture, of learning to use digital technologies for own specific personal needs; or even just to play around with technology, to break it and test knowledge and methodologies. This calls to open source collaboration, online resource sharing, DIY solutions, finding re-usable tech and recyclable hardware, and low-cost tech-artistic creations. The connection with the open-source coding movement and with the hacking concept then becomes a key aspect of prac-tice and philosophical application. Activism and socio-political voice, as a response to the age of technology driven economical powers, shapes too. But as the outsider artistic element of these critical practices now becomes more institutionalised within art galleries, museums, universities, then the degrees of the artistic work also tends to change.

I work wearing different hats, such as practicing as an artist, lecturing Art&Design at univer – sity, researching creative methods via people's participation and engagement, producing and managing digital programmes and events, delivering workshops, curating pop-up digital engaged installations. Currently I teach at University Arts London + I am Producer of the Digital Studio at Tate + Art&Design Associate with the Mozilla Foundation. I have worked in different international settings, and at different degrees of digital art intervention in formal and informal spaces for making.

As part of my process, I also actively write down notes and thoughts. They are often key-words and conceptual notes that I use as part of reflection, and then also re-use for ethno – graphic purpose. In this piece I have decided to collect and share some questions + some thoughts related to my practice

within the field of digital art making, specifically reviewing how that connects with participation and public engagement. Tensions and reflections on the artistic practice, tech-creative production, new or old technologies, credits, outputs, next steps for professional growth constantly come to the table.

As an alternative contribution to the Journal of Peer Production, I take this piece as a sort of conceptual open diary of my comments and questions that I have archived at the end of work – shop developments, exhibitions, pop-up installations, lectures in different spaces and places. Questions that help me reflect about space…about my practice…about why I do it; reflections that perhaps are also understood by other practitioners in the field and that I hope can just be inputs for further reflections and debates.

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// there is a need to evaluate more and constantly reflect critically on our practice.
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TensionS

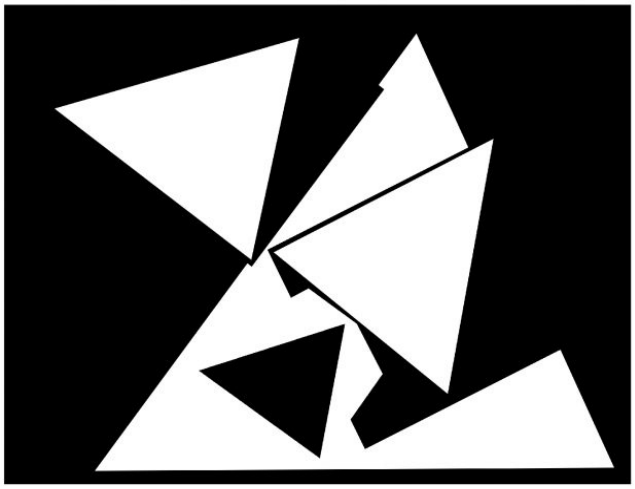
EthicS

OpeN

PoliticS

Should I take that job? Is this a job? Should I consider it as such? Are we getting lost in the daily business of it...is there a right monetisation of the practice? Who is gaining what?

Is this a flow of belief for change? And if so, what change? Is it change?



How do we **balance** expectations?

How do we **balance** revelations?

How do we **balance** innovation?

The space was small and a bit of a mess…no technical support at all. At the end, it really did not matter. We just made a quick set-up, something very DIY that was just enough to have a sort of interaction with the computer. The wifi did not work…no way, I thought…

…we opened-up pages of the process…we shared coding and concepts…the public loved it. We loved it. Coming from a more structured setting and a more framed space, it was a challenge…more for the frame of mind that for the practice though.

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(Share_Marketing);

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// What is inclusion? And, what are the risk of classifying it?

Is there a Mainstream inclusion?

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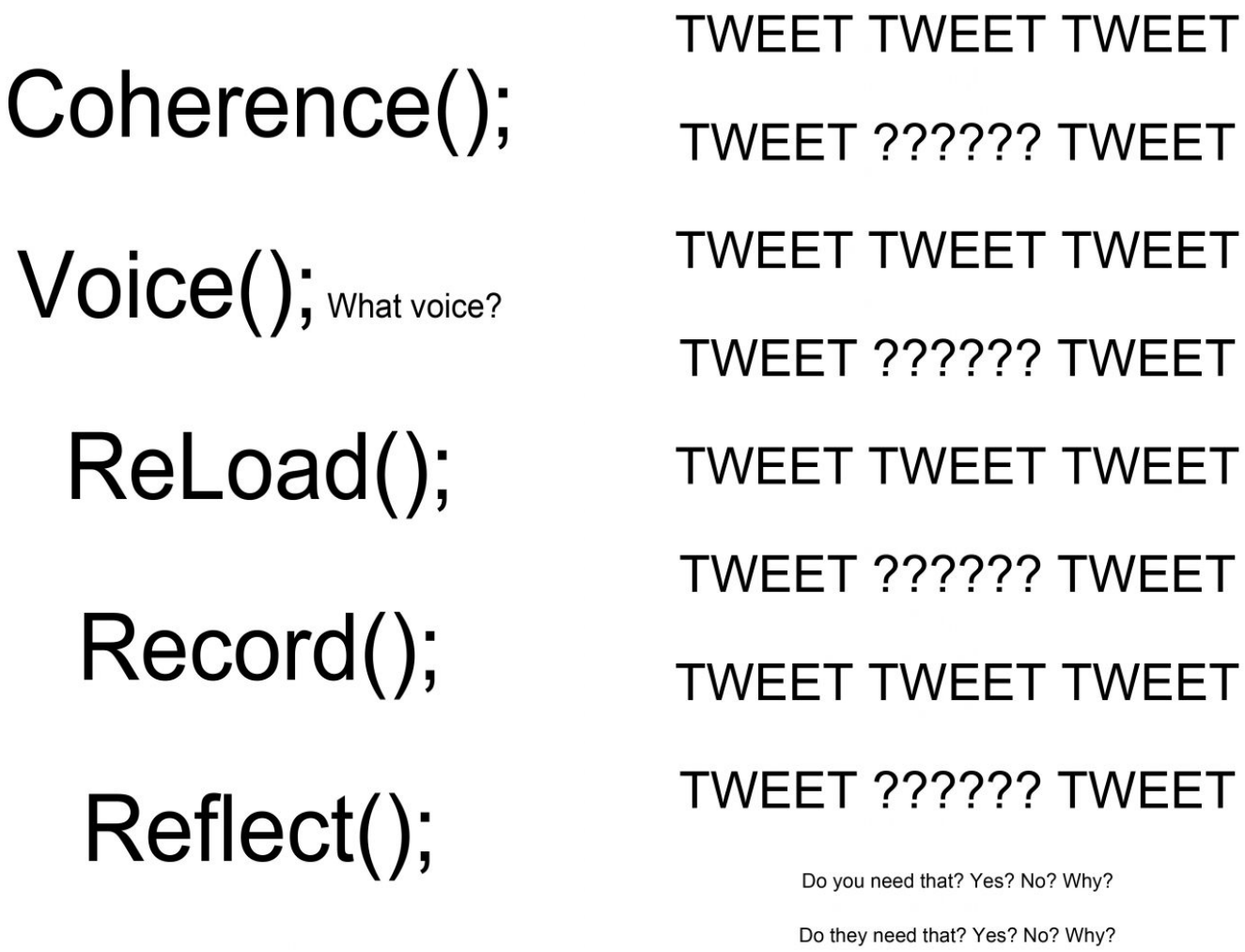

Diversity.

Diversity of methods.

Diversity of flows.

Diversity of interactions.

Diversity of thoughts.

Diversity of outputs.

Diversity of public.

Diversity of approaches.

Diversity of platforms.

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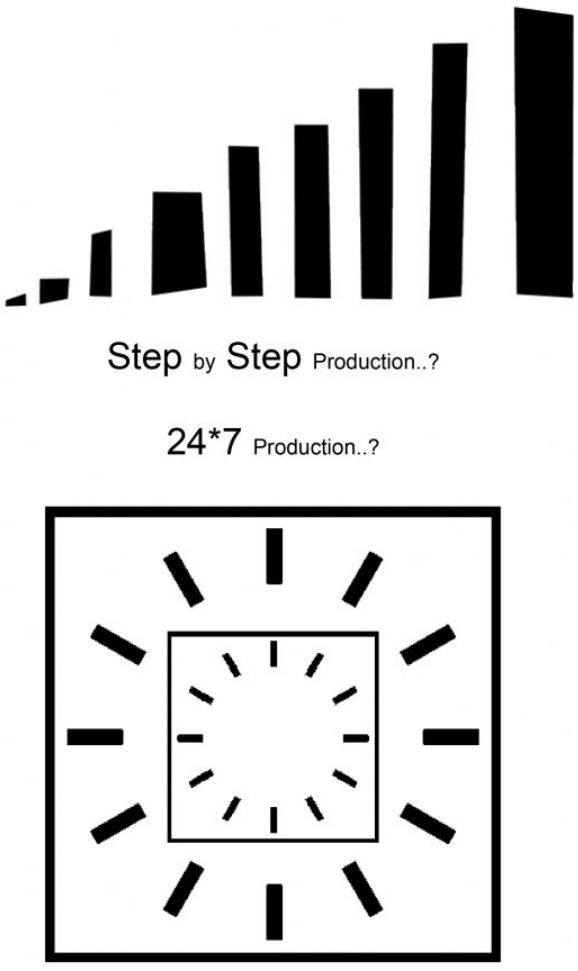

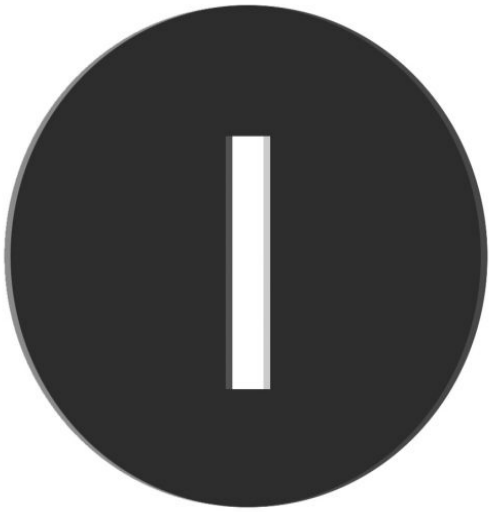

NET EQUALITY

NET INEQUALITY

WEB DOMAIN – Domain of who?

Live streaming? Cross-connecting?

Balancing e-participation? E-voice?

Moderating? Or is it controlling?

Engineering.

Collaboration.

Balance.

Rest.

Practicing.

Researching.

Writing.

Sharing.

// reflecting ( );

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ABOUT THE AUTHOR

Luca M. Damiani is a Media Artist, Media Design Lecturer at London College of Communication (University of the Arts London), and Digital Producer at Tate. Luca practices internationally in the fields of the Arts, Digital Media and Visual Culture. He works and experiments with creative techniques such as digital tech, illustration-animation, photography, coding and mix-media. With a multi-methodological approach, Luca explores artistic processes re-considering the combination of methods. His ongoing research-based practice looks at various areas of applied art and design, with the main focus on technology, digital art, neurodiversity, and human rights. A published artist-author of several books and papers, his work is actively exhibited and showcased. Luca has collaborated with many institutions, such as: Computer Arts Society, Mozilla Foundation, NESTA, Framestore-VFX, Disney, Amnesty International, BBC, TATE, V&A and Thames & Hudson.

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THE DISTORTING EFFECT OF MONEY, AND OTHER LESSONS LEARNED BY A MAKERSPACE FUNDER

by Molly Rubenstein, Benjamin Linder & Kofi Taha

When the Artisan's Asylum, a makerspace in Somerville, MA, started back in 2010, neither the maker movement nor the concept of innovation had yet captured the imagination of educators, policy makers or the general public. Institutional funders looking to use collaborative fabrication spaces to achieve their education or development goals were virtually non-existent — we know because two of us were part of the leadership team beating the bushes for funding in those early days. Most makerspaces were started just as Artisan's Asylum was — by groups of loosely connected people looking to serve their individual needs by pooling their own scant resources. It was "stone soup" for creative people and money was scarce.

As the movement grew, people began to ask how we were able to create, in such a short time and with so little institutional financial support, such a large and vibrant community and space. We always offered the same advice: don't look for a magic pre-designed solution. Don't get distracted by shiny new cutting-edge digital fabrication tools. Stop drafting architectural plans and lists of equipment, and engage with your users instead. Find out what those users want and need the space to accomplish, and what they are excited to bring to it. Engage users in the launching and leadership of the space. Create structures that distribute decision-making power and ownership (along with appropriate boundaries and systems in order to minimize conflict). Make sure that there are opportunities and reasons for the community to interact, collaborate, and have fun together both inside the center and outside in the community. The rest will follow.

It was a constant challenge for Artisan's Asylum to raise the increasing funding we needed to operate comfortably, however, and other grassroots makerspaces struggled with the same problem. The constant struggle to achieve and maintain financial sustainability made it difficult for us to serve our communities and to have the impacts we dreamed about. After we each moved on from our work with the Asylum, we often wondered, without devaluing the amazing people that made exciting things happen every day, what the organization might have achieved if more financial resources had been available. And we wondered how we might proceed if we had the chance to start over again with a full complement of human and financial capital when launching or supporting a new makerspace. In 2012, we had the opportunity to find out.

That year our teams at Olin College and MIT D-Lab joined a consortium of colleges and universities that banded together as the International Development Innovation Network (IDIN). IDIN obtained a grant from USAID's Global Development Lab to execute a program aimed at training and supporting innovators around the world to develop technological solutions to problems related to poverty. One part of that plan was to fund and support the establishment of collaborative design and fabrication centers based in developing economy countries.These centers became our partners in the IDIN Innovation Center Program.

As the lead implementers of this new program, we were suddenly the ones offering funds rather than

the ones desperately trying to raise them. We thought that our decades of experience in development combined with our grassroots makerspace experience in the US would protect us from some of the failure modes we had observed in other social impact ventures and makerspaces. We were going to ensure that users were effectively engaged, that the right emphasis was placed on tooling, programming and community building, but now we could just take off some of that financial pressure. We were cautious, but this could work, right? Not perfectly.

We started out well enough, working to implement many of the best practices we had learned from experience. We took a number of actions to encourage centers to respond dynamically to the needs of their unique participants and context. We worked with leaders who had experience in design, fabrication, or engineering and were already doing community engagement, co-design, or social impact work in the communities around their centers. We partnered with centers where communities had explicitly expressed interest in the services that an innovation center would provide. We offered no standard model and encouraged local partners and community members to design and evolve their centers in whatever way felt most appropriate and compelling to them.

But we also had money to grant, and this money came from an entity that had specific development goals that it needed to achieve in order to continue to receive its own funding. As the maker movement and innovation itself attracted more and more attention, pressure mounted to quantifiably demonstrate what outcomes could emerge from these creative spaces. With the simultaneous increase in both interest and pressure, the IDIN Innovation Center Partner program doubled its cohort size three years in a row. We found that despite our experience and best intentions, these centers were experiencing familiar challenges generating both user participation and funding. This indicated to us that in certain specific and consistent ways they were still struggling to effectively engage their community members:

Many center leaders were hesitant to depart from what they understood our model to be. Even though we didn't believe we were presenting a standard vision or model of what an innovation center was supposed to be, local leaders looked to IDIN examples. They tried to replicate what they saw at fabrication shops at our partner colleges and universities or ones set up for our collaborative design trainings (International Development Design Summits), without sufficiently adjusting those designs to leverage the inherent strengths or address the unique needs of the communities they worked in. In some cases, they also focused on serving stakeholder groups they had seen IDIN engage when there were other local community members more interested in the services they could provide.

Some in-country leaders were still considered outsiders in the communities they were engaging. Although they came from the same country as the center's community, many of the leaders we selected had higher levels of formal education and international exposure than the primary community participants they were trying to engage. They often came from different economic strata or spoke a different local language. While some were able to overcome these differences, others could not use their own interests and experiences as relatable models for their users, which made it more challenging for them to find the best ways to engage local leaders and participants.

Centers struggled to find the right mix of stakeholders to engage. Many makerspaces in advanced economy countries struggle to financially sustain themselves; in contexts where the primary users are earning only a few dollars a day, the challenge is even greater. In these contexts, it is critical that leaders engage a variety of different stakeholders, including some with more resources, as participants, clients, or sponsors. In large part due to requirements from our own funders, some innovation centers felt pressured to serve the

greatest number of users with the highest need rather than engage with a variety of stakeholders in order to develop a locally sustainable set of programs. Others veered too far in the other direction, splitting their attentions between very different stakeholder groups. This divided focus made it more difficult for them to present a coherent picture of their mission to potential funders and to have a meaningful impact.

These are not easy challenges to overcome but, in collaboration with our IDIN Innovation Center Partners, we have been iterating on a variety of strategies to address them.

EXPERIMENTING WITH THE MODEL

Increasingly, centers are working to depart from the examples they have seen in traditional IDIN fabrication shops and events in order to find a better fit, balancing what they are able to provide with the needs and interests of their local community.

- ***Adjust the center audience.*** The Centro de Inovação Vila Nova Esperança (CI-VNE), our partner center in a *favela* or historically low-income and unplanned urban area in São Paulo, Brazil, initially wanted to focus on engaging the residential community's adults in design education. However, they soon found that with the adults away at work much of the week, it was children under 16 who most often showed up to the workshop space. By embracing their strength as a youth engagement center, they have not only been able to start sharing their successes in that arena with partners and funders, they have built more trust and seen increased involvement from adult community members.
- ***Adjust the center offerings.*** The Tet Centre was established to support a cluster of villages around Pader, Uganda, but over time it became clear that, although centrally located, the physical shop was too far from those communities to effectively meet their everyday needs for tools and workspace. The team decided to outfit each of the individual village cooperative fabrication groups with a communally managed fund, which is now being used to purchase small tools and build simple shelters for their products.
- ***Look at a variety of models.*** We have shifted our support strategy these past two years from one-on-one calls with each center leader to working group calls with all of the center leaders together. We have also worked to connect them with other maker movement networks through a variety of channels including conferences organized by other networks like the Global Innovation Gathering and FabLearn. This has increased the variety of models our partners have to learn from and made it easier for them to think about ways to vary their own models based on their unique contexts.

LEADING FROM THE INSIDE

In our experience, the best way to encourage participation by any desired group of users is to have a representative from that group in a leadership position.

- ***Support leaders establishing centers in their own communities.*** One center leader was a college student at one of our partner universities, the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana, when he joined our network. After founding a Creativity Group and helping to run two successful Makers Fairs at the university, he launched Kumasi Hive, an education center and incubator for social impact software and hardware startup ventures. Most of these ventures were started by current or former KNUST students and their colleagues from other schools in the area. Kumasi Hive currently incubates thirteen businesses, has fourteen active partnerships, and so far on average has engaged almost 1000 participants each year.
- ***Promote participants to leadership***

positions. In some communities where we work, it is unrealistic to rely solely on insiders to spearhead a new center. In communities new to the concept of a community design and fabrication space, for instance, leadership is most likely to start from the outside. But that doesn't mean that it should remain that way. Project DEFY's founder was inspired by his own frustrating experiences in the formal education system, but it was together with his neighbors in the village of Banjarapalya, India, that he formed the vision for the Project DEFY Nooks: low-cost self-education centers that inspire passion for discovery and problem-solving skills. The DEFY team is now in the process of opening their fourth Nook, and their outreach team is made up of two community members, a young man and young woman who are former participants and have been running the Nook in Kaggalipura for over a year. Incidentally, having a woman on their leadership team not only increased participation in the Nook from community members in general, but from women and girls in particular.

BALANCING STAKEHOLDERS

Finding the right balance between having a sufficient variety in stakeholders to allow for financial sustainability and maintaining sufficient focus to have meaningful impact has been one of our partners' greatest struggles. As advisors, connectors, and capacity builders, we have used a range of tactics in order to support partners in navigating this terrain, but as a funder, there is one particular strategy that we have found that makes a big difference.

- ***Fund only some of a center's expenses, at the right scale for the team and context.*** We have experimented with offering grants ranging from $3,000 to $80,000 in a year. We have learned that while grants that are too small may not be enough to help a center reach its next stage of development, grants that are too large can lead to a rapid expansion of staff and programming that the center then cannot secure continuous funding to sustain. We have shifted to funding programs that are able to match what we offer with an equivalent amount either from other grants, earned revenue, or gifts and donations. This has helped not only to ensure the financial sustainability of the program but also the investment of key stakeholders from within the ecosystem.

Needing money is an inherent challenge when trying to build and sustain any shared design and fabrication space, particularly one dedicated to having social impact in communities with limited financial resources. But the fact is that simply having the money it needs does not on its own ensure a center's success. Funding introduces pressures that can operate in opposition to the innovative and adaptive thinking that these types of entities are often touted as promoting. And perhaps most importantly, this can be true even if the funder explicitly expects otherwise and advises against these pressures. We offered no model and we taught inclusive innovation methodologies to our grantees. Even so, the gravitational force of the resources at play consistently pulled attention away from the user engagement and other core elements that we have found to be critical in developing the best version of what these collaborative organizations can be.

We hope the strategies for user engagement and responsive program design listed above are helpful for leaders of collaborative design and fabrication initiatives around the world. For

funders, we hope it is clear that the mere pairing of funding with flexible advice is not enough to support center leaders in keeping their orbits appropriately aligned to what will make their programs most impactful and sustainable; funding and other support mechanisms must explicitly incentivize user-oriented, context-responsive programming. As

organizations at many different scales and vantage points continue to explore strategies for achieving specific educational or development outcomes through these type of organized creative communities, first, let's all acknowledge the inherent influence and potentially distorting effect that money can exert, and, second, let's commit ourselves to remaining true to the deep fundamentals around stakeholder engagement that experience shows is essential to organizational health and long-term success.

ABOUT THE AUTHORS

Molly W. Rubenstein manages programming at MIT D-Lab to promote the development of resilient and inclusive ecosystems for innovation and entrepreneurship around the world. She ran the International Development Innovation Network (IDIN) Innovation Center Program, providing funding, mentorship, and peer-learning for local organizations promoting the development of innovative, inclusive solutions improving the lives of people living in poverty in 15 countries. Molly spent four years co-managing the rapid growth and development of the Artisan's Asylum, one of the largest and longest-standing grassroots community makerspaces in the US. She has been training and mentoring collaborative community innovation, fabrication, and entrepreneurship programs since 2013.

Dr. Benjamin Linder is Professor of Design and Mechanical Engineering at Olin College. His teaching and research efforts are directed at developing techniques and approaches that further a more ecologically connected and socially just design practice. He investigates the roles people, products, and firms can play in the realization of sustainable communities with an emphasis on local innovation, collaboration, and collective action. One of the first board members at Artisan's Asylum, he is a co-lead organizer of the International Development Design Summits (IDDS) and co-founder of the International Development Innovation Network (IDIN), and served on the IDIN Innovation Center Program committee from 2012-2017.

Kofi Taha, as part of MIT's D-Lab, focuses on asset-based approaches to community-driven livelihood and quality-of-life technology design, mostly in communities where people on average earn less than $3 a day. He has co-facilitated village-level design-thinking trainings in Uganda and Haiti, helped interdisciplinary teams commercialize social impact products in Ghana and Tanzania, provided support to local innovation centers in Brazil, Colombia, and India, and helped build IDIN, a global community of 1000+ innovators, entrepreneurs, researchers, and educators. Regardless of context or focus, what drives his work is a commitment to improving the use of inclusive practices that lead to practical solutions and equitable opportunity.

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CREATING TOGETHER, LEARNING TOGETHER: PRACTICES OF YCAM IN COOPERATION WITH MACHINES

by Kazutoshi Tsuda,Mitsuhito Ando, Kazuhiro Jo & Takayuki Ito

The Yamaguchi Center for Arts and Media [YCAM] is a public art center located in Yamaguchi City, Japan. The center pursues new artistic modes of expression through the incorporation of media technology and hosts a diverse range of programs such as exhibitions, film screenings, workshops, performing art pieces and live events. Since its opening in 2003, the center has produced many art pieces, of which, over 40 pieces (such as Forest Symphony 2013, supersymmetry, 2014 Dividual Plays, 2015[1] and many more), has toured throughout the country, and exhibited in over 150 cities. At the core of the center is the concept of "Creating together, learning together."

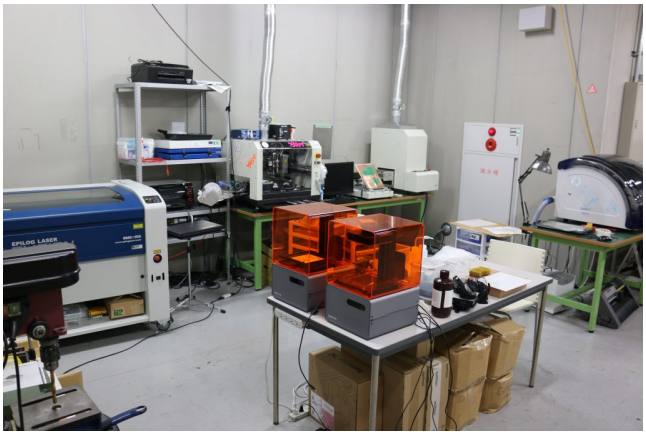
Photo by Eiji Ina

With the world transitioning to an information-driven society, from 1988 Yamaguchi City with a population under 200,000 was making plans for cultural facilities, and in 1993 the master plan for the center were drawn up. Arata Isozaki was selected as the architect, and he announced his design for the proposed cultural center in 1998. Thanks to Isozaki's advice that the plan must include aspects of "Software" in addition to "Hardware", several workshops were conducted among the invited curators and artists deliberating over how would the center be operated. After rigorous dialogue with the citizens, the creation of the center's "initial configuration" was accomplished.

At the time of its opening, a prominent "Hardware" feature of the center was its layout of several functional facilities lined up side by side on a single shared platform, which offered versatility and flexibility in their capacity to be utilized according to it's purpose and needs. A prominent "Software" feature was its centralization in "people". With the concept of housing over 20 young and specialized staff members which include curators, educators, engineers, and designers, are producing diverse range of programs with the R&D process is possible. Such open collaboration between the artists (domestically and internationally) and the in-house team is a rare and unique example among existing theaters and art centers, especially among the Japanese art centers.

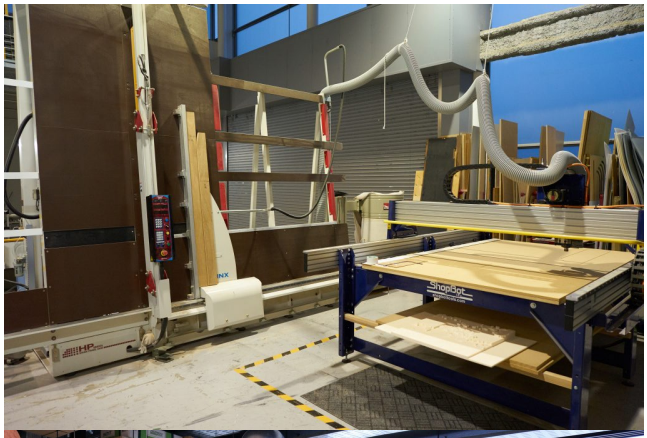
With the presence of the dedicated in-house team, the know-how acquired in the center's design and production can be accumulated internally, and can facilitate a flexible adaptation and upgrading of equipment in response to the advancement of technology. Adjacent to the studios where artwork would be announced and displayed, were the lab spaces where art is designed and produced. Gradually, these functions of such spaces were expanded. While there were spaces for making electronics and wood work during the early years, by its 10th year, after 2013, the facility incorporated new equipments such as 3D printers and laser cutters[2] for digital fabrication. These advance the center's development process for rapid prototyping by leaps and bounds.

The next good example, the incorporation of a PCB board plotter, chip mounter, and reflow oven. With such equipments in place, electronics prototype could be developed internally between the staff and artist. Even production orders of 1,000 units could now be handled in-house with only the circuit boards being outsourced for mass production (*e.g.* SWO stay, 2017).



For giant sculptures, in 2016, the center incorporated a large-format CNC router that played a big part in the creation of a specialized playground embedded with media technology (Korogaru garden, 2016). Thanks to the R&D framework curated within the span of the project, upgrades during the exhibition period were made possible. Such process successfully drew out the spontaneous and self-motivated expression from the participating adults and children[3]. In 2015, a bio lab space was established, incorporating field research and workshop development with the goal of integrating biotechnology into this expansion process (YCAM Bio Research, 2015-; DNA of Forests, 2016-).

With future efforts encompassing not only art, but an experimental prototyping along with the local community, the center's role in developing the region has become much greater. In 2014, with the fab lab network and the local resources, the center took on the issues of challenging rural areas such as establishing pop-up fab labs in mountainous area of Yamaguchi City. Until now, YCAM has utilized its advantage as a public institution to further pursue R&D processes in hope for some new discoveries which could be beneficial and inspiring in contributing towards the arts, society and people. In order to develop further, starting in 2016 the center took its first steps towards becoming an academic research institute.



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ABOUT THE AUTHORS

Kazutoshi Tsuda is a researcher with a background in engineering and design. His research interests include personal fabrication, material cycles, and design for sustainability. He is a member of Fab Lab Japan Network, a co-founder of Fab Lab Kitakagaya, and also a local instructor of distributed education program Fab Academy ("How to Make Almost Anything") and Bio Academy ("How to Grow Almost Anything"). After working as an assistant professor of engineering design at Osaka University, he is working as a researcher of "YCAM Bio Research" at Yamaguchi Center for Arts and Media [YCAM] since 2016.

Mitsuhito Ando works as hardware engineer at YCAM. He uses digital fabrication tools based on rapid prototyping for each project such as "Korogaru Koen Park" series, "Parallel Eyes" and "AIDJ". Through the prototyping, he exploring possibility of digital fabrication tool such as "ofxEpilog" he developed. At Institute of Advanced Media Arts and Sciences (IAMAS) he has been researching the form of expression that utilizes digital fabrication tools applying rapid prototyping techniques. After graduating, he joined YCAM.

Kazuhiro Jo is a practitioner with a background in acoustics and interaction design. He has been presenting his practices in a form of works of art as at museums and festivals, as well as papers at international journals and conferences with his

projects such as “The SINE WAVE ORCHESTRA”, “Generative Music Workshop”, and “phono/graph”. After working at IBM Japan, Newcastle University, Tokyo University of the Arts, and IAMAS, he took up his position as an associate professor in Faculty of Design at Kyushu University, Fukuoka, Japan as well as an advisor at YCAM.

Takayuki Ito is R&D Director of YCAM InterLab. He started to work for YCAM as a technical staff from 2003 and has since, worked with many productions of art installations, dance, live performances, educational programs and R&D projects. He has been leading “YCAM InterLab”, the R&D section for artistic/educational production as a director since 2011.

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REPAIR CAFES

by Martin Charter

BACKGROUND

Over the last thirty years different perspectives on waste have been seen around the world by the author. Back in the late 1990s in Zimbabwe, a crashed car was scavenged for materials in hours for re-use and in Japan, in the mid 2000s there was a visit to five of 50 electronics recycling factories that had been launched the day the country's waste electronics legislation came into place. Closer to home, an increasingly number of "end of life" phones, laptops and printers are being stored in my and other people's lofts and garages. In a recent capacity building project with five re-use social enterprises in Hampshire in the UK, many products were observed that had been designed – deliberately or not – *not* to be easy to disassemble, and fix or repair. Companies can design products to be easier to be disassembled and repaired to enable extended product life but they are generally not doing so at present.

Between 1995-2016, the author's team at The Centre for Sustainable Design ® at University for the Creative Arts (UCA) organised twenty-one Sustainable Innovation conferences; this enabled an annual "rain check" on trends and developments in sustainable innovation and design. Over the last few years, an increasing number of examples of grassroots, social, circular innovation have emerged in presentations at the events. These initiatives have been driven by, for example: the increased availability of online videos, information and fora focused on 'making, modifying and fixing' products; increased sharing and collaboration of ideas and information; new "places and spaces" being set up to enable citizens to make, modify and fix products; use of new forms of funding e.g. crowdfunding to kick start initiatives; the emergence of new tools (e.g. 3D printing); and growing interest in thinking globally but acting locally.

Repair Cafés have emerged as citizen-driven initiatives to enable the fixing (or repair) of products at a community level. Repair Cafés are part of broader movement of 'Makers, Modifiers and Fixers' where individuals and groups of individuals that are 'making, modifying and fixing' products are coming together in physical places and spaces that include Hackerspaces, Makerspaces, Fab Labs and Tech Shops.

FIXER MOVEMENT

The 'Fixer Movement' is being empowered by online platforms, social enterprises and community-based organisations (Charter & Keiller, 2014). This includes:

- Online fixing sites: For example, IFixit ifixit.com an innovative WIKI based website that provides free online repair guides, solutions and 'how to' videos for a wide range of consumer electronics and other products, including clothing.
- Social Enterprises: For example, The Restart Project restartproject.org ; a London-based social enterprise that encourages and empowers people to use their electronics longer, by sharing repair and maintenance skills, through Restart events in communities and with companies in the UK.
- Repair Cafés: "Repair Cafés are free

> ‘community-centred workshops’ for people to bring consumer products in need of repair where they can work together with volunteer fixers, to repair and maintain their broken or faulty products. In addition to repair, many Repair Cafés provide assistance with product modification, particularly to clothing to improve fit and appearance” Charter & Keiller, 2016 (The Repair Cafe WIKI)

REPAIR CAFES

My personal journey into the world of repair cafes started at the Hannover Fair in Germany in 2014, with an inspiring presentation by Martine Postma, the founder of the then Repair Café International Foundation (RICF). It highlighted that there had been no primary research into the activities of repair cafes and so the author approached Martine to collaborate on a survey to understand what was going on worldwide. An online survey was then completed by The Centre for Sustainable Design ® (CfSD) at University for the Creative Arts (UCA) with RCIF (Charter & Keiller, 2014). Key findings based on 158 respondents included that the motivations for volunteers in engaging with repair cafes were both social and environmental including giving “something back to community” and “feeling involved with others”, alongside helping repair broken stuff. A conference was then organised to disseminate the findings which generated a lot of interest. As a result the author decided to translate the results of the survey into action and opened dialogue with a local Farnham-based NGO – Transition Town Farnham – to collaborate on the development and delivery of Farnham Repair Café (FRC) as a university-community project and “living laboratory” focused on local social and circular economy activities.

The Repair Café Foundation (now Repair Cafe International Foundation (RCIF)), was founded by an ex-journalist Martine Postma in the Netherlands in 2011 to enable people to come together to provide a free service to their community to help repair and therefore, to extend the life of products that would otherwise end up as waste. RCIF has 1,562 Repair Cafés in 35 countries registered on their website (Repair Cafe International, 2018); however, there are indications that there are also a significant number of other Repair Cafés and other community repair workshops that are not on the RCI website.

A second worldwide survey of Repair Cafes was completed in 2016 by CfSD at UCA with RCIF (Charter & Keiller, 2016b) produced a range of other interesting findings based on 317 respondents:

- Start-up phase: 72% of Repair Cafés had operated for two years or less compared with 95% in the 2014 survey.
- Citizen-driven: 46% of Repair Cafés were founded by an informal group of motivated individuals and 44% by a single motivated individual.
- High repair rates: 63% of products brought to Repair Cafés sessions were repaired

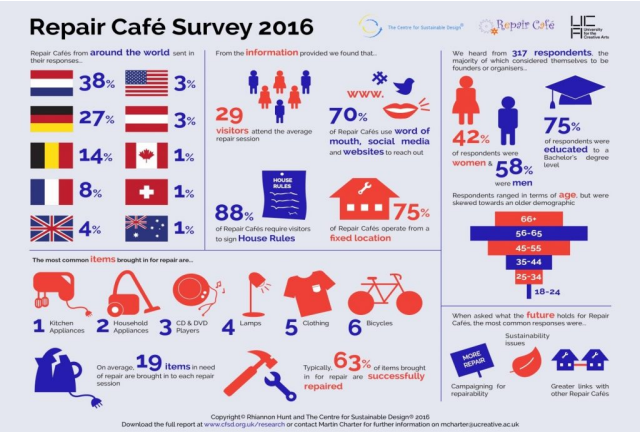

Figure 1: Global Repair Café Survey, 2016

FARNHAM REPAIR CAFÉ (FRC): CASE STUDY

After an initial innovation workshop, two pilot sessions were organised to test and learn about the logistics of operating a Repair Café. FRC was launched in February 2015 and in April 2017 became a charity (Farnham Repair Café, 2018a). FRC is based at a fixed venue – United Reformed Church in Farnham – and as at March 2018 has held

thirty-six, 2.5 hour sessions. Repair stations are organised for a range of consumer products e.g. electronics, mechanicals, bicycles, clothing, furniture and creative (upcycling). Volunteer repairers bring their own tools and equipment, and a number of repairs are finally completed by volunteers at 'home workshops'. The FRC management team have developed methodologies to collect data to measure the impact of activities.

Fig 2. Farnham Repair Cafe

Getting involved and taking forward FRC as community repair project has been both rewarding and challenging particularly in moving FRC to be the UK's first repair café charity.

Visitors to FRC	1571
Repairs completed	553
Repair rate	63%
Landfill diversion	1.8 tonnes
CO2 reduction	15.0 tonnes
Satisfaction	98%*
Citizen savings	£40,827**

*** Exit survey of visitor satisfaction of FRC service**
****As result of repairs completed, cost saved from not having to buy a new product**

Table 1. Farnham Repair Café: Results to date (April 2018)

Below are a range of reflections and lessons learnt by the author based on three research surveys (Charter & Keiller 2014, Charter & Keiller 2016b,c) and experience from organising thirty-six FRC sessions.

GROWING INTEREST

The number of Repair Cafes in the UK has roughly doubled to 58 during 2017-18; and has increased to 1562 worldwide (Repair Cafe International, 2018). FRC has seen growth in interest and attendance since launch.

Year	Number	Visitors	No. of Products – Booked in	No. of Successful Repairs	% of Successful Repairs	Landfill diversion (kg)	CO2 reduction (kg)	Satisfaction (%)
2015	10	403	159	98	61%	369	3068	N/A
2016	11	395	197	126	63%	352	2929	97%
2017	10	524	344	218	64%	646	5376	98%

2018	5	249	185	111	62%	438	3649	99%
Total	36	1571	885	553	63%	1804	15022	98%

Table 2. FRC Analysis as at April 2018

FRC actively promotes the impact of its monthly sessions through social media and has been featured on national and local radio, Brazilian television and local press. Awareness of FRC is beyond the local community and it has been consulted by a new repair cafe start-up in Northern Ireland and visited by others from Surrey, Hampshire and Essex; FRC sees supporting the set-up of other repair cafes as part of its wider mission.

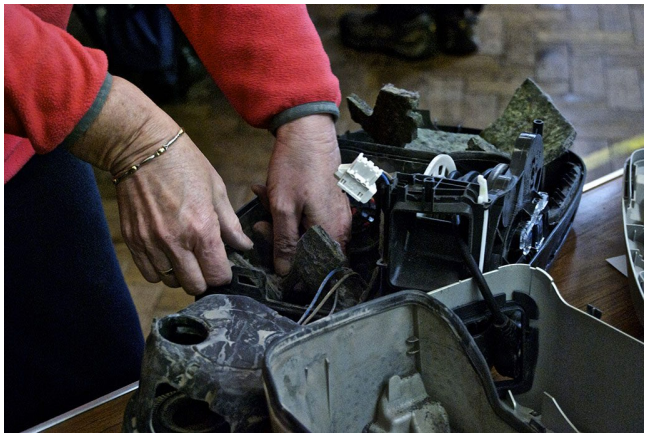

Fig 2. Vacuum cleaner repair

AUDIENCE

The average age of visitors (product owners) to FRC is 53, with 86% of respondents aged over 45 (Charter & Keiller, 2016c); the on-going challenge is to attract younger people and younger families who perhaps tend to buy new stuff rather than get it repaired. There has been a very positive reaction to FRC – "what a great idea", "I really don't like to throw things away" – especially amongst older visitors. FRC has a 98% customer satisfaction rate since monitoring started in June 2016 and has only faced two problematic customer cases that both arose partially as a result of failure in administrative systems that led to changes. Many visitors don't have the skills to fix products and a number of older visitors have lost the dexterity to sew, for example. Talks at local events and feedback at FRC sessions has reinforced the existence of a segment of more advanced, citizen repairers that are fixing products by using online videos, fora and information with some using FRC for a 2nd opinion when they cannot repair a product. Research amongst FRC visitors has also identified that over 60% of visitors (and volunteers) stated that attending FRC had made them more or much more likely to attempt to repair their own products (Charter & Keiller, 2016c). This finding reinforces the FRC philosophy that is exemplified by the twitter hastag #sharerepair e.g. the desire by FRC that visitors physically observe the repair process and learn.

WHAT VISITORS SAY ABOUT FRC

> "There is a wealth of experience, knowledge and goodwill in the team, and patience in dealing with the variety of issues brought in!"
>
> "How wonderful to have something repaired, and to not need to buy a new hairdryer. Very grateful."
>
> "What brilliant, supportive people live in our community! How to check to see if hoover belt is broken. Thank you so much."
>
> "Don't throw anything away as it may be repaired – quickly too at the Café."
>
> "How skilful repairers are, how confident, how generous with time and expertise."
>
> "10/10 for dogged persistence to repair a tricky fault in my iron. Thank you! Keep up the good work."

VOLUNTEERS

FRC experience is that there are amazing repair

skills that are just sitting in the community. There are an estimated 72 repairers and other volunteers who have attended at least one session with a core group of around 20-25 who regularly attend sessions. FRC repairers are essentially problem-solvers with many being "owner-completers" who like to solve/complete repairs even if they cannot be completed within 2.5-3 hour sessions. A small number of dedicated repairers will often take jobs back to their home workshops, then attempt fixes and return products to owners direct – fixed or unfixed. Several repairs have gone beyond logical fault diagnosis and fixing, with repairers having developed creative solutions resulting from lateral thinking (Farnham Repair Café, 2018b). Repairers at FRC are happy to bring their own tools as there is a lack of appropriate facilities at the venue which makes storage of tools, parts and components impractical. Replacement parts and/or components that are identified by repairers during the repair process are purchased online by visitors and brought for fixing at the following session.

LOCAL COMMUNITY

Repair is the key mission of Repair Cafes but it has become clear that there is a social role in helping to provide a friendly place that contributes to a sense of community. In addition, there are local economic benefits. FRC has saved Farnham citizens an estimated £40,827 through repairs – meaning that new products do not have to be bought. FRC has worked closely with local stakeholders throughout its development: United Reformed Church provide a hall for FRC and repairers and visitors use URC's adjacent Spire Café for teas and coffees; Farnham Town Council has been consistently positive about FRC and, for example, allowed FRC to temporarily piggy-back on its insurance policy whilst it was in transition towards a charity; University for the Creative (UCA) provided legal advice via its solicitors in relation to the charity submission and donated a PAT tester. The connection between CfSD at UCA has been integral to development and has provided administrative support, statistical analysis and ad hoc research. Reports have been uploaded to www.cfsd.org.uk/research to provide wider access, presentations have been given, articles written and two chapters have been completed on Repair Cafes and FRC for an upcoming book (Charter, 2018).

Figure 3. Strengths of Farnham Repair Café, Charter & Keiller, 2016c

PRODUCTS

There are a wide range of products that have been booked in and fixed over 36 sessions, from a reel-to-reel tape machine to a Japanese doll to toys and vacuum cleaners. Electronics is always the most busy work station, and is a "hive of activity" with the highest proportion of repairers. Unpublished research by a FRC trustee based on 261 repairs between 14th February 2015 to 9th July 2016 provided some interesting data.

- Clothing is the most common product needing repair
- 4 failure types account for nearly 50% of all repairs
- It costs less than £1 in new parts to successfully repair over 70% of products

The top five products needing repair were: clothing (12%); lighting (7%); portable radio/CD players; sewing machines; and bicycles. The top five product failures were: worn or torn (14%); poor maintenance/adjustment (12%); broken/cracked parts (11%); electronic parts at component level

(11%); and internal or external wiring failures – excluding power cords (7%).

Fig 3. Clothing repair

At the time of the analysis, FRC had an impressive repair rate of 82% leaving FRC successfully or partially repaired:

- 63% Successfully completed repairs of
- 19% Partially completed repairs
- 5% Not completed but advice given
- 12% Unsuccessful

Over 36 sessions, the FRC repair rate is 63%, which is in line with the global average of 63% (Charter & Keiller, 2016b). FRC repair rate is still intuitively very high given that there is only 2.5 – 3 hours to repair products per session, and a small group that complete repairs at home workshops.

Fig 4. Toaster Diagnosis

ORGANISATION

Although FRC is a charity, it is run in a business-like manner, with all trustees having been senior managers or directors of companies. There has been strong commitment and motivation by all key stakeholders related FRC particularly the trustees and repairers. A full set of promotional tools have been used to attract repairers and visitors (product owners) to FRC including local press, local radio, e-marketing, Facebook, Twitter, leaflets, presentations to local groups, local social networks and a webpage http://cfsd.org.uk/events/farnham_repair_cafe/. Minimisation of risk is a key issue for FRC and it has a health and safety policy, and public liability and products liability insurance in place. Research completed by FRC indicated that few insurance companies or brokers understood Repair Cafes and the actual risks associated with products fixed at Repair Cafés; with the biggest concerns being electrical and electronics products. FRC's venue is the United Reformed Church (URC) which is a central location in the town; other venues were considered but were rejected as URC is an excellent

location with nearby car parking facilities.

DEVELOPMENT

FRC was originally set up as a collaborative project (without legal status) by CfSD at UCA and Transition Town Farnham (TTF). Several early UK based Repair Cafes had been set up as projects within Transition Towns (Transition Towns, 2018). The difference compared to other similar situations in the UK was that FRC was set-up as collaboration between CfSD at UCA and TTF, and not set-up directly by TTF and therefore TTF did not, metaphorically, own it. The arrangement was useful in the start-up phase of FRC as TTF provided access to its bank account to deposit donations and small grants, and make payments, and the relationship also enabled FRC to be incorporated into TTF's existing insurance policy. However, the relationship became more challenging over time due to differing perspectives from the individuals involved, differences in vision, gaps in practical experience between the collaborators, and differing commitments. A key lesson learnt is to always thoroughly understand who you are "getting to bed with" before you formalise collaborations to ensure that all key stakeholders involved in the development and organisation of a Repair Café have the same vision, motivations and expectations.

In Q4 2016, it was decided by the FRC core team that it should apply to register as a charity to gain legal status. The application process was quite challenging, as was untangling activities from TTF. The registration was submitted in January 2017 and after various rounds of comments with the Charity Commission, charity status was granted on 18th April 2017. FRC has also helped spawn other initiatives and research. As a result of connections made through a separate repair project in Hampshire that CfSD had partnered in, one of the FRC trustees now leads a Men's Shed (Men's Sheds, 2018) at the Furniture Helpline (Furniture Helpline, 2018) in Bordon. Another trustee is completing a postgraduate degree in sustainable development at the University of Surrey with his thesis focused on CO2 impacts of repair cafes in the UK. Also additional research amongst FRC visitors was completed by the Open University that was presented as a research paper at a conference (Dewberry et al, 2016). FRC is presently considering the development of additional added-value services for the local community, and increased dissemination its experience and understanding.

Fig 5. A tape recorder is fixed

TEN LESSONS FOR REPAIR CAFÉ START-UPS

- Establish a clear vision: short, medium and

long-term
- Ensure there is a person who is prepared to lead, coordinate and plan activities
- Recruit a steering board drawn from repairers and other local citizens with business experience
- Establish clear financial and marketing plans
- Identify a central location with good access for visitors (product owners) and repairers
- Ensure you have a legal structure for insurance and banking purposes
- Use a range of communication tools to attract repairers and visitors
- Develop a positive and friendly community-oriented atmosphere
- Monitor the environmental, social and economic impact of repair activities
- Develop good relationships with key local stakeholders (local council, university, etc.)

ENDNOTE

Experience from Repair Cafes is illustrating that a significant number of products are not designed for disassembly and reparability. There is growing discussion over whether this is as a result of built-in product obsolescence arising from bad design and/or deliberate strategies. Transitioning towards the Circular Economy (CE) at a 'product level' or product circularly will mean that there will need to be increased focus on the use or re-use stage of the lifecycle rather end-of-life. It will be about proactively building into the design and development phase of products-services, strategies to enable maintenance, repair, refurbishment, reconditioning, upgrading, remanufacturing, parts harvesting and finally recycling. In CE terms, recycling should be thought of, as much further down the line, than in traditional lifecycle thinking. Implementing product circularity should lead to an extended lifecycle perspective where products, components and materials are kept in the system to the highest value over the longest time period. However, a key issue is not to lose the lifecycle perspective and to become myopic e.g. trade-offs with other environmental aspects need to be considered. CE does not operate in a vacuum, and is not a panacea (Charter, 2018).

NOTE

Martin Charter also created a poem based on his repair café experiences, which was performed at the Tate Modern in October 2017, and is available in two online formats (Charter 2017a, Charter 2017b, Charter 2017c).

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EXCELLENCE IN THE MAKER MOVEMENT

by Em O'Sullivan

Over the past six years I've witnessed a growing awareness of issues of diversity and accessibility in the global maker movement. The lack of women, people of color, people with disabilities, older adults, people with caring responsibilities, and people with low incomes has increasingly become part of the everyday conversations happening in makerspaces and at maker events, and maker communities are actively taking steps to become more inclusive.

Figure 1. Machines Room in London, England has a high proportion of women staff and members. They make sure to place this front and center in their promotional material.

Several feminist makerspaces have popped up around the USA ("Feminist and women's hackerspaces," n.d.). These are welcoming spaces for artists, crafters, technologists, and entrepreneurs who may struggle to feel comfortable in mainstream, men-centered spaces due to their gender identity (Fox, Ulgado, & Rosner, 2015; Toupin, 2014). They are typically organized around a strong Code of Conduct that lays out what is expected of their members, and—unlike in most other makerspaces—potential members are vetted before being able to join.

Figure 2. Double Union, a feminist makerspace in San Francisco, CA, have hung a framed copy of their anti-harassment policy and Code of Conduct on their kitchen wall.

Figure 3. Mothership HackerMoms, a feminist makerspace in Berkeley, CA, provide childcare facilities and a playroom so members can bring their young children along.

By providing childcare facilities, hosting consent workshops, building feminist and anti-racist book and zine libraries, and providing bursaries for members with low incomes, these spaces signal to woman-identifying and non-binary people that makerspaces are for "people like them". These feminist spaces give the lie to the claim that the lack of gender diversity in the maker movement is because women just aren't interested in hacking and making things (Henry, 2014), and this is increasingly being reflected in efforts to provide visible markers of gender inclusivity in mainstream makerspaces.

Figure 4. Consent literature available at Seattle Attic, a feminist makerspace in Seattle, WA.

Figure 5. A mural at Noisebridge, an anarchist hackerspace in San Francisco, CA, depicts the iconic figures Nikola Tesla and Margaret Hamilton. Hamilton coined the term "software engineering" and led the team who developed the flight software for the Apollo space program.

Maker communities have long clustered around areas of economic deprivation, often (ironically) due to the collapse of manufacturing industries that the maker movement has been heralded as reinventing (Anderson, 2012; Dawkins, 2011). The institutionalization of the maker movement and the recent attention paid to it by governments and private companies has led to makerspaces and maker events receiving grant funding and sponsorship as part of schemes to regenerate or upskill local communities (Libraries Taskforce, 2017; The White House, 2015). Often these spaces find that it is not enough to simply provide tools and expect people to use them: they need to make themselves relevant to their community by developing a dialogue with them and finding out how to meet their needs.

Figure 6. The Remakery is based in a multi-ethnic area of south London, England. They were funded via a grant from their local council to provide workspace and tools for reducing waste and tackling social issues in their local area.

Figure 7. Knowle West Media Centre is an arts centre and charity in an area of economic deprivation in Bristol, England. Their makerspace, The Factory, runs free digital design and fabrication workshops for local residents.

As the maker movement matures, communities who were previously focused on figuring out the basic logistics of organizing a makerspace and staying afloat now have more time, money, and energy to devote to including under-represented groups. Makerspaces are working with members with physical disabilities to make their workshops more accessible (Brady, Salas, Nuriddin, Rodgers, & Subramaniam, 2014; Meissner et al., 2017), makerspaces for young people are dedicating resources to engaging youth from low income or minority ethnic families (Calabrese Barton, Tan, & Greenberg, 2017; Vossoughi, Escudé, Kong, & Hooper, 2013), and national networks of Men's Sheds are supporting the spread of makerspaces for retired men at risk of social isolation (Cordier & Wilson, 2014).

Figure 8. rLab in Reading, England, hosts the Reading Repair Cafe where local residents can get help to repair broken items. They are currently updating their workshop to be more accessible for members and visitors who use wheelchairs.

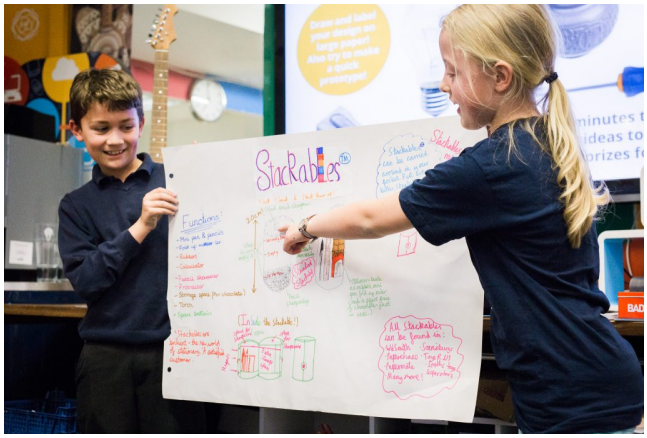

Figure 9. MakerClub is a network of after-school clubs in makerspaces across England. Their Bright Sparks program provides free memberships for children from low income families, sponsored by local digital businesses. (Photo by Chris Quigley, courtesy of MakerClub)

There is still a lot of work to be done, and many challenges to face. Makerspaces struggle to find affordable, accessible properties with adequate parking or good public transport connections. There are ethical issues around receiving grant funding—particularly from military organizations such as DARPA (Altman, 2012; Vossoughi, Hooper, & Escudé, 2016)—and sponsorship agreements typically introduce extra administrative overheads for makerspace organizers. The current political climate in the USA is making things difficult for feminist organizations, and there is a continuing lack of attention to the absence of people of color and the maker movement's role in gentrification. It is therefore essential to keep these conversations going in our maker communities, and to continue to strive to be excellent to each other.

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SPACE, GATHER, MAKE: SHARED MACHINE SHOP SOUND

by Kat Braybrooke, Adrian Smith & Vasilis Moschas

In autumn 2017, contributors to this special issue collaborated with Tate Digital Learning to curate Space Gather Make, a mini-exhibit at Tate Modern in London that would use creative methods to explore the sights and sounds of shared machine shops from around the world as part of the Art:Work week.

In thousands of cities, towns and villages – from Japan to Ghana, from the Norwegian Artic Circle to the United Kingdom – shared machine shops have been opening up where people can learn how to make things with mentors, tools and equipment. Space. By asking what worker-owned labour looked and sounded like at these sites, this issue's practitioners envisioned their sites as distinct visual environments for a new kind of audience, each imbued with its own kind of 'life'.

The exhibit also included a piece by London-based sound artist Vasilis Moschas, who created a conceptual audio installation that explored the unique sound environments of participating sites.

Combining practitioner contributions with machine-produced beats and spoken-word poetry, his work further illustrated the typical on-site experiences of flow, discontinuity, repair and breakdown.

SHARED MACHINE SOUND

REPAIR

DISCONTINUITIES

FLOWS

BREAKDOWN

This is a free-flowing piece which explores the ways

shared machine shops sound. It was built from recordings contributed by site collaborators, combined with external machine-produced sounds which include manipulated samples and synthesised beeps.

Its four chapters are based on the different aspects of production: There is FLOW in working processes, assembly lines and automation; DISCONTINUITIES in machine interferences, problems and multitasking; REPAIR when the machines get damaged; and eventually BREAKDOWN, the inevitable fate of both machinery and humanity.

The piece finishes with a human voice singing, implying the belief that the only thing that will remain at the end of it all is us, the human beings. But the voice, instead, comes only through a radio.

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- The 'Repair' poem featured in *Shared Machine Sound* is entitled 'Sounds of a Repair Cafe' by Martin Charter.

