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

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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 embourgeoisement 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.

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