

JOURNAL OF PEER PRODUCTION ISSUE 12: MAKERSPACES AND INSTITUTIONS

VOLUME 1 OF 3

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 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 reinvention 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 Paulo 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 Paulo 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 initiatives 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 succeeded 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, Mitsuhiro 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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REFERENCES

- Asaro, P 2000, 'Transforming society by transforming technology: The science and politics of participatory design', *Accounting Management and Information Technologies*, vol. 10, pp. 257–290.
- Biehl, J 2007, 'Bookchin breaks with anarchism', *Communalism: International Journal for a Rational Society*, pp. 1–20.
- Boeva, Y & Chies, B 2017, 'Yet another industrial revolution — A dialogue on tensions in digital fabrication'. *EASST Review*, vol. 36, no. 1. Available

- at:
<https://easst.net/article/yet-another-industrial-revolution-a-dialogue-on-tensions-in-digital-fabrication>
[Accessed 20 April 2017].
- Bookchin, M 1967, 'Towards a liberatory technology', *Anarchy* vol. 78.
- Braybrooke, K & Jordan, T 2017, 'Genealogy, culture and technomyth: Decolonizing Western information technologies, from Open Source to the maker movement,' *Digital Culture & Society*, vol. 3, no. 1, pp. 25-46.
- Chapman, J 2009, 'Design for (emotional) durability,' *Design Issues*, vol. 25 no. 4, pp.29-35.
- Ehn, P 1988, *Work-oriented design of computer artifacts*. Arbetslivscentrum, Stockholm.
- Fuenfschilling, L & Truffer, B 2014, 'The structuration of socio-technical regimes — Conceptual foundations from institutional theory,' *Research Policy*, vol. 43, no. 4, pp. 772-791.
- Gauntlett, D 2013, *Making is connecting*. John Wiley & Sons, London.
- Hall, S, Massey, D, & Rustin, M (eds) 2013, *After neoliberalism? The Killburn manifesto*. Lawrence & Wishart, London.
- Hirsch, P & Lounsbury, M 2015, 'Toward a more critical and "powerful" institutionalism,' *Journal of Management Inquiry*, vol. 24 no. 1, pp. 96-99.
- Levy, D & Scully, M 2007, 'The institutional entrepreneur as modern prince: The strategic face of power in contested fields,' *Organization Studies*, vol. 28, no. 7, pp. 971-991.
- Mackenzie, D 1984, 'Marx and the machine,' *Technology & Culture*, vol. 25, no. 3, pp.473-502.
- Di Maggio, P & Powell, W 1983, 'The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields', *American Sociological Review*, vol. 48, no. 2, pp.147-160.
- Matthewman, S 2011, *Technology and social theory*. Palgrave Macmillan, Basingstoke.
- Maxigas & Troxler, P 2014, 'We now have the means of production, but where is my revolution?' *Journal of Peer Production*, vol. 5.
- Munir, K 2015, 'A loss of power in institutional theory,' *Journal of Management Inquiry*, vol. 24, no. 1, pp.90 -92.
- Noble, D 1984, *Forces of production: a social history of industrial automation*,. Knopf, New York.
- North, D 1989, 'Institutions and economic growth: A historical introduction,' *World Development*, vol. 17, no. 9, pp. 1319-1332.
- Oliver, C 2018, 'Strategic responses to institutional processes,' *The Academy of Management Review*, vol. 16, no. 1, pp. 145-179.
- Pache, A & Santos, F 2013, 'Inside the hybrid organization: Selective coupling as a response to competing institutional logics,' *Academy of Management Journal*, vol. 56, no. 4, pp. 972-1001.
- Scott, W 1995, *Institutions and organizations*. Sage, Thousand Oaks.
- Smith, A 2014, 'Technology networks for socially useful production,' *Journal of Peer Production*, vol. 5. Available at:
<http://peerproduction.net/issues/issue-5-shared-machine-shops/peer-reviewed-articles/technology-networks-for-socially-useful-production/> [Accessed 2 April 2018].
- Suddaby, R 2015, 'Can institutional theory be critical?' *Journal of Management Inquiry*, vol. 24, no. 1, pp. 93-95.
- Willmott, H 2014, 'Why institutional theory cannot be critical,' *Journal of Management Inquiry*, vol. 24, no. 1, pp. 105-111.
- Zietsma, C & Lawrence, T 2010, 'Institutional work in

the transformation of an organizational field: The
interplay of boundary work and practice work',
Administrative Science Quarterly, vol. 55, pp.
189-221.

INSTITUTIONALISATION AND INFORMAL INNOVATION IN SOUTH AFRICAN MAKER COMMUNITIES

Chris Armstrong, Jeremy de Beer, Erika Kraemer-Mbula, Mieka Ellis

This article explores the current modalities at play in respect of institutionalisation and informal innovation within maker communities in South Africa. A national scan in 2016-17 generated data on more than 20 maker communities across South Africa. The data provide insights into a number of management, spatial and activity variables present in the practices of the maker communities and their members. This article focuses on two of the dimensions found to be present when looking across the management, spatial and activity variables: institutionalisation and informal innovation. Institutionalisation is conceptualised as resulting in, and from: (1) formalisation of maker communities' practices; (2) partnerships between maker communities and formal organisations; and (3) embedding of maker communities in formal organisations. Informal innovation is conceptualised as manifesting in: (1) constraint-based innovation; (2) incremental innovation; (3) collaborative innovation; (4) informal approaches to knowledge appropriation; and (5) innovation in informal networks/communities in informal settings. Our data show that since the emergence of the maker movement in South Africa in roughly 2011, there has been an increase in institutionalisation of, and within, maker communities. At the same time, we find that there continues to be a strong spirit of informality in the communities, with most of the communities, including the relatively more-institutionalised ones, actively seeking to preserve emphasis on informal-innovation modalities. Our conclusion is that, in the present stage of evolution of the South African maker movement, elements of institutionalisation appear to be largely offering synergies, rather than tensions, with the ethos of informal innovation. Such synergies are allowing South African maker communities to play an intermediary, semi-formal role, as mediating entities between formal and informal elements of the country's innovation ecosystem.

Keywords: maker movement, South Africa, maker communities, innovation, institutionalisation, formalisation, informal innovation, constraint-based innovation, incremental innovation, knowledge appropriation, informal networks, informal communities

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INTRODUCTION

Vocal proponents of the maker movement, notably in the United States, position the movement in largely utopian terms, as an adoption of do-it-yourself (DIY) approaches to innovation, and as a means through which consumers become creators (*Make*, n.d; Dougherty, 2012). Through tinkering and learning in hands-on environments, makers are said

to be re-appropriating the production ideals of pre-industrial times. Anderson (2012) has declared that the movement represents the "New Industrial Revolution". The origins of these narratives lie in the launch of *Make* magazine in 2005 and in the first Maker Faire a year later, both in the US state of California. Other largely uncritical works are those by Hatch (2014) and Doorley et al. (2012).

While there is indisputable value in these US-originated founding narratives of the maker movement, their applicability is far from universal. They skew towards a developed-world, middle-class

(even upper-class, in some contexts) orientation (see Maker Faire, 2014). There is, meanwhile, an emergent body of work that takes a jaundiced view of the narrowness (see maxigas & Troxler, 2014; Mozorov, 2014) of the founding narratives, and literature that seeks to interrogate the meanings and modalities of making beyond middle-class, developed-country settings. Murray and Hand (2014) analyse the position of making in the Indian “digital humanities” context by examining, inter alia, the practice known as “*jugaad*”, which, they argue, “while having similarities to hacking, should be understood in its culturally and historically specific contexts [...] rather than being forced into a Western template” (Murray & Hand, 2014, p. 152). Braybrooke and Jordan (2017) compare the prevailing Western casting of the maker movement with narratives around making in certain contexts in Peru, India and China, finding that Western narratives may, inter alia, have the effect of rendering “Global South and non-Western perspectives invisible” (Braybrooke & Jordan, 2017, p. 2). The maker movement in developing-country contexts (India, South America) also receives treatment as a manifestation of “grassroots innovation” in the Smith et al (2016) volume.

The research we describe and analyse in this article contributes to the broadening of maker movement narratives, in our case through exploration of the activities and orientations of maker communities in the South African context. In South Africa, a country of stark disparities of wealth, we find a wide variety of narratives present in the minds of its makers. All the narratives bear traces of the founding US narrative, but in most cases the traces are faint, and in many cases extremely faint. We find in our contact with South African makers a strong sense of the uniqueness of the South African case. In this article we demonstrate and interrogate some of the particularities of the South African case through presentation of data and analysis in respect of two dimensions of the movement: its growing institutionalisation and its adherence to an ethos of informal innovation. Our focus on these two dimensions is grounded in the work of the research

collective of which we are part, the Open African Innovation Research (Open AIR) network. Among Open AIR’s core aims is to explore potential tensions between formalising and informalising trends in respect of innovation, knowledge management, knowledge appropriation, and linked phenomena.

Accordingly, it is our view that research into the emergent maker movement in African national settings must look closely at the degree to which informal innovation modalities are at home in the evolving South African movement, which is becoming increasingly institutionalised. In this article, we call the innovation and knowledge appropriation practices typical of informal sectors “informal innovation”. We explore the ways in which informal-innovation modalities are, at present in South Africa’s maker communities, interacting with the trends—in some respects countervailing, in other respects synergistic—towards increased institutionalisation.

Our exploration is based on a national scanning exercise we conducted in South Africa in 2016-17, which generated primary data on the management, spatial and activity characteristics of more than 20 maker communities across five of the country’s provinces. The data allow us to identify a range of sustainability themes that warrant further investigation in the South African and other national contexts: stability of funding and revenue model; establishment of niches, reputations and brands; knowledge appropriation and intellectual property (IP); elements and degrees of institutionalisation; robustness of communities of practice; embeddedness in broader networks; orientations towards innovation and enterprise development; and socioeconomic inclusion. Each of these themes is given broad-spectrum treatment in an Open AIR working paper (see De Beer et al., 2017). In this article, we home in on institutionalisation, and its potential implications for informal innovation.

We consider evidence of institutionalisation as manifested by: (1) formalisation of maker communities’ practices; (2) partnerships between

maker communities and formal organisations; and (3) embedding of maker communities in formal organisations. We consider evidence of informal innovation as manifested by: (1) constraint-based innovation; (2) incremental innovation; (3) collaborative innovation; (4) informal approaches to knowledge appropriation; and (5) innovation in informal networks/communities in informal settings, i.e., either physical (e.g., clusters) or virtual (e.g., online) networks/communities. This analysis illuminates several key characteristics of South Africa's maker movement, and exemplifies an approach that could also be useful for research into the maker movement in other African contexts, in other developing-world contexts, and in developed-country contexts.

The next section of our article introduces select literature relevant to institutionalisation and informal innovation in the maker context, and outlines our conceptual framework for interrogating institutionalisation and informal innovation as exhibited by South African maker communities. The third section elaborates on our data collection methodology for the national scan and how we ordered the collected data. Section four provides our findings in respect of the maker communities' degrees of institutionalisation and their orientations towards informal innovation. The final section provides our analysis and conclusions in respect of institutionalisation, informal innovation, and related dynamics in the South African maker movement.

RELEVANT LITERATURE

Making and Institutionalisation

The aforementioned founding, US-originated narrative of making is ambiguous in respect of institutionalisation, simultaneously extolling the virtues of non-institutional home-garage-based making and the virtues of nationally-franchised, for-profit, user-fee-based TechShops. The ambiguousness of the founding narrative in respect of institutionalisation is illustrated by the range of iterations, depending on who is writing or talking,

that are given the status of "makerspace". When a small group of people decides to have weekly maker meetups in someone's garage, the group may soon start to speak of the garage as a makerspace. At the same time, hackerspaces, FabLabs and TechShops are all also typically awarded makerspace status. As Cavalcanti (2013) points out, the oldest of these labels, "hackerspace", has its origins in software-hacking (and thus for some people should not be conflated with a makerspace, which typically has a pronounced hardware element). The FabLab and TechShop brands, meanwhile, are much more recent. The FabLab ("Fabrication Laboratory") brand originated at the Massachusetts Institute of Technology (MIT), and a FabLab is supposed to be free (or very low-cost) to the user. TechShops, which began in California, are for-profit franchises that have been established in several US cities (Cavalcanti, 2013). Because of its emphasis on free or low-cost use (but with quite clear specifications regarding which equipment should be present), the MIT-conceived (and widely exported, including to South Africa) FabLab model is more institutionalised than the aforementioned garage makerspace but at the same time less institutionalised than the TechShop model with its user-fee-centric approach. The tools typically associated with makerspaces are 3D printers, laser-cutters and CNC (computer numeric control) machines, as well as trade tools such as sewing machines, woodworking tools, and welding equipment (Wang et al., 2015; Lorinc, 2013).

Making and Informal Innovation in Africa

The first African Maker Faire, coordinated by a Ghanaian entity separate from the aforementioned US-based Maker Faire brand, was staged in Ghana's capital, Accra, in 2009 (Maker Faire Africa, n.d.). Four more Maker Faire Africa gatherings followed, in Nairobi (2010), Cairo (2011), Lagos (2012), and then South Africa's commercial capital, Johannesburg (2014). The US Maker Faire brand has also found its way to Africa, including two South African appearances: the 2015 Maker Faire Cape Town and the 2016 Mini Maker Faire Cape Town.

Ekekwe (2015) and Yoder (2015) write about how the maker movement in Africa provides an opportunity for growth across the continent, through entrepreneurship and through skills development for problem-solving. Hersman (2013) discusses the interface between makerspaces and innovation in Africa. Waldman-Brown et al. (2013) posit that Ghana's informal-sector innovators can benefit, and avoid stagnation, through linkages with formal governmental and NGO actors, and, accordingly, Waldman-Brown et al. (2014) find that Ghana's FabLabs and makerspaces, as relatively formalised technological workshops, need to build strong linkages with informal-sector artisans' workshops.

Valuable existing research into innovation dynamics in Africa's informal sectors is present in Ndemo and Weiss (2017), De Beer et al. (2014, 2016), De Beer and Armstrong (2015), De Beer and Wunsch-Vincent (2016), De Beer et al. (2016), Kraemer-Mbula (2016), and Kraemer-Mbula and Wunsch-Vincent (2016). In addition, the Open AIR network is actively researching and writing about Africa's maker movement, via ongoing research in Ghana, Egypt and Kenya as well as developed-developing country comparisons via companion research in Canada. Open AIR has produced two Working Papers on the South African maker movement, the first an in-depth look at maker communities in Gauteng Province (Kraemer-Mbula & Armstrong, 2017), the second outlining results from the 2016-17 national scan that produced the data for this article (De Beer et al., 2017). Open AIR's work has led to a conceptualisation of the maker movement as cutting across its thematic research areas of *informal-sector innovation, high technology hubs, and indigenous and local entrepreneurs*, and thus providing fertile ground for exploring dimensions of institutionalisation and formality/informality (Open AIR, n.d.).

Making, in our view, has the potential to focus and channel some of the abundant informal-sector innovation on the continent towards 3D-printing,

CNC-machining and other digitally-enabled hardware. Moreover, as its name suggests, the Open AIR network has an interest not only in innovation generally but also, more particularly, in modes of innovation oriented towards openness and open collaboration among groups of innovators. We find that the work of Von Hippel (2005, 2016) and Benkler (2006), while grounded in developed-world experience, is relevant to African maker contexts, through its emphasis on user innovation (Von Hippel, 2005). User innovators exist in a dynamic ecosystem of peer production (Benkler, 2006) characterised by open collaborative innovation (Baldwin & Von Hippel, 2011). This kind of open innovation is, however, not to be confused with an alternative conception in which the *firm* is open to licensing intellectual property (IP) with others (see Chesbrough, 2006). The sort of open innovation we see as associated with African makers typically has little to do with formalised IP concerns, and is akin to what Von Hippel (2016) has recently labeled "free" innovation.

Institutionalisation Modalities

In framing the notion of institutionalisation, we were guided to a great extent by the conceptualisation implied by the *Journal of Peer Production (JoPP)* call for submissions on "Institutionalisation of Shared Machine Shops", as follows:

The dilemmas of institutionalisation (regarding both the *formalization* of practices and the fact that many practice-based spaces are now being *embedded* within larger organizations like museums, municipalities and businesses) provide us with an opportunity to critically examine networks, spaces and futures that may be assembling in this new phase. (*JoPP*, 2017, italics in original)

In line with this JoPP conceptualisation, two elements of institutionalisation that we consider in the data analysis for this article are: formalisation of maker communities' practices and embedding of

maker communities in formal organisations. Additionally, due to evidence from the national scan of a large and growing number of collaborations and funding relationships between the South African maker communities and formal entities, we include an additional conceptualisation of institutionalisation: maker communities' partnerships with formal organisations (such as universities, government/state entities, private-sector entities, non-profits). In sum, the three institutionalisation modalities we focus on are:

- formalisation of maker communities' practices;
- partnerships between maker communities and formal organisations; and
- embedding of maker communities' in formal organisations.

The listing of the institutionalisation modalities in this order—from internal practices, to partnerships, to embeddedness—reflects what we see as a hierarchy of institutionalisation, i.e., increased institutionalisation of a community's internal practices is unlikely to have as strong an institutionalising influence as embedding of the community in a formal entity.

Informal-innovation Modalities

In conceptualising the notion of informal innovation, we draw to a great extent on the work of De Beer et al. (2016) and Kraemer-Mbula (2016) in the edited volume *The Informal Economy in Developing Nations: Hidden Engine of Innovation?* (Kraemer-Mbula & Wunsch-Vincent, 2016). De Beer et al. (2016) speak of innovative behaviour in the informal economy as being characterised by, among other things: “constraint-based innovations”, “[i]ncremental rather than radical innovations”, innovations taking place “in geographically concentrated regions in a collaborative manner”, and “lack of effort or methods to appropriate techniques, designs and final outputs” (2016, pp. 80-81). Kraemer-Mbula (2016) analyses, inter alia, the “incremental” and “collaborative” modes of

innovation practised by South African informal-sector manufacturers of products for home and personal care (2016, p. 162). Drawing on these conceptualisations, the five informal-innovation modalities we focus on are:

- constraint-based innovation;
- incremental innovation;
- collaborative innovation;
- informal approaches to knowledge appropriation; and
- innovation in informal networks/communities in informal settings, i.e., either physical (e.g., clusters) or virtual (e.g., online) networks.

METHODOLOGY

Methods

We collected our primary data on South African maker communities in 2016-17 via the following means:

- desk analysis of each community's online presence, supplemented by email correspondence;
- in-person site visits to maker community premises, including attendance at certain communities' weekly meet-ups;
- informal in-person and videoconference discussions with participants in communities;
- formal, in-depth research interviews with participants, conducted in-person and via videoconference;
- convening of a South African Maker Movement Workshop in Pretoria in March 2017, attended by 50 participants including representatives of South African maker communities from three provinces and representatives from South African government departments, state agencies and NGOs;
- video-recorded interviews with makers during and after the Pretoria workshop; and
- scrutiny of post-workshop documents distributed via email by the South African Maker Collective.

Maker Communities Examined

A “snowball” (accumulative) sampling method generated referrals from one maker or maker community to another. When our research began in early 2016, we were initially only aware of maker communities present in the country’s four largest urban areas: Johannesburg, Pretoria, Cape Town, and Durban. In the course of the research, we became aware of additional communities in the cities of Port Elizabeth, Bloemfontein and Ekuherleni, and in the town of Knysna. We also witnessed the emergence of new maker communities during the course of our research in and around Johannesburg and Ekuherleni—e.g.,

Made In Workshop, ZS6COG Fablab, Tsakane FabLab, Duduza FabLab and Soweto eKasi Lab—and still more maker communities in their planning stages, e.g., Vosloorus FabLab and the maker facilities planned for eKasi Lab Alexendra, eKasi Lab Mohlakeng and eKasi Lab Sebokeng. By the time this article is published in 2018, it is likely that there will be additional communities, in existence or in their planning stages, that we had no awareness of during our research. Such is the dynamism and momentum of the movement in South Africa. Table 1 below provides a provincial breakdown of the 25 maker communities on which we collected data, and a listing of our primary data sources for each.

Province	Maker Community	City/town	Year of formation	Sources of primary data
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Gauteng province	House4Hack	Centurion	2011	online presence, email correspondence, site visit, informal discussions, formal interviews, national workshop, video interview at workshop
	Binary Space	Vanderbijlpark	2012	online presence, email correspondence, site visit, informal discussions, formal interviews, workshop participation, video interview at workshop
	Tinker Space, University of Johannesburg (UJ) Resolution Circle tech hub	Johannesburg	2012	site visit, informal discussion
	Makerlabs	Johannesburg	2013	online presence, site visit, formal interviews
	Geekulcha Makers	Pretoria	2014 (Geekulcha founded in 2013, its Geekulcha Makers programme in 2014)	online presence, email correspondence, site visit, informal discussions, formal interviews, national workshop, video interview at workshop
	Sebokeng FabLab, Vaal University of Technology (VUT) tech hub	Sebokeng	2014	online presence, site visit, informal discussion
	Ekueherleni FabLabs (Thokoza, Tembisa, Tsakane, Duduza)	Ekueherleni	2011-16	online presence
	Digital Innovation Zone (DIZ) Maker Space, University of the Witwatersrand (Wits) Tshimologong tech hub	Johannesburg	2015	online presence, site visits, informal discussions, formal interview, national workshop, video interviews at workshop
	University of Pretoria (UP) MakerSpace	Pretoria	2015	online presence, site visits, informal discussions, formal interviews, national workshop, video interview at workshop
	eKasi Lab Ga-Rankuwa	Ga-Rankuwa	2015 (Lab established in 2014, maker-type work in 2015)	online presence, site visit, informal discussions, formal interviews, national workshop
	I Make Makers Lab, Makers Village	Irene	2015 (Makers Lab established in 2015 as part of existing Makers Village)	online presence, site visit, informal conversations, formal interviews, national workshop, video interview at workshop
	Made In Workshop	Johannesburg	2016	online presence, site visit, informal discussion
	eKasi Lab Soweto	Johannesburg	2016	online presence, site visit, informal discussion
ZS6COG Fablab (formerly BNT Masinga Trading and Projects)	Heidelberg	2016	online presence	

Western Cape Province	Kluyts MakerSpace	Knysna	2012 (in present factory location since 2015)	online presence, email correspondence, informal Skype discussion
	Craft and Design Institute (CDI) Product Support Space	Cape Town	2013 (the broader CDI was established, as the Cape Craft and Design Institute (CCDI), in 2001)	online presence, site visit, informal discussion
	Workspace	Cape Town	2013	online presence, site visit, informal discussion
	Curiosity Campus *	Cape Town	2013	site visit, informal discussion
	The Bank	Cape Town	2014	online presence, site visit, informal discussion
	Maker Station	Cape Town	2014	online presence, email correspondence, site visits, informal discussions, national workshop, video interview at workshop
	Modern Alchemists, Women in Tech Cape Town, Arduino Cape Town (all coordinated by KATO Technology)	Cape Town	2014	online presence, informal discussions, national workshop, video interview at workshop
Kwazulu-Natal (KZN) province	University of Cape Town (UCT) Maker Society*	Cape Town	2015	online presence, email correspondence, site visit, informal discussions, national workshop, video interview at workshop
	The MakerSpace	Durban	2013	online presence, email correspondence, site visit, informal discussions, formal Skype interview, national workshop, video interview at workshop
Free State Province	Bloemfontein FabLab, Central University of Technology (CUT) tech hub	Bloemfontein	2006 (not a vibrant makerspace until recent years)	online presence, site visit, informal discussion
Eastern Cape Province	WERK	Port Elizabeth	2014	online presence

Table 1: Communities Consulted, and the Sources of Primary Data

* the Curiosity Campus and UCT Maker Society in Cape Town were no longer active at the time of finalisation of this article in early 2018. Source: De Beer et al. (2017)

Though we collected some form of data on 25 maker communities, we draw our findings and analysis only

from data collected on communities with whom we made direct contact. We exclude from our findings and analysis those communities for whom our only data source was the community's online presence. We also exclude Curiosity Campus from our analysis because it shut down very shortly after our 2016 site visit and informal discussions. We do, however, retain the UCT Maker Society in our analysis because it only shut down in the latter half of 2017 and one of its representatives attended the March

2017 Maker Movement Workshop in Pretoria. Thus, in our view, it represented a meaningful part of the South African maker ecosystem during the period of our study. Accordingly, our findings are based on data from 21 communities (see Table 3 below).

We consistently refer to “makers”, we acknowledge the fact that some of the communities we study—e.g., the eKasi Labs and the Craft and Design Institute (CDI) Product Support Space in Cape Town—do not position themselves first and foremost as making communities. Rather, to the best of our understanding, these communities see making as one of the mix of activity dynamics present in their communities. Also, it must be noted that for some of

the communities studied, their years of formation were difficult to state with precision, because the communities were initially established with a non-making-centric purpose, e.g., as an enterprise incubator or accelerator, and only later evolved to include a makerspace element.

Other Entities Consulted

In addition to data on the above-listed maker communities, we also collected data on initiatives and bodies that support the South African maker movement. The three key entities in this category, and the primary data sources used for each, are listed in Table 2 below:

Entity	Location	Source of primary data
South African Maker Collective	nationally dispersed network	online presence, email correspondence, informal discussions, formal interviews, national workshop
Maker Library Network (MLN)	internationally dispersed network	online presence, informal discussions with MLN partner makerspaces
htxt.africa	online news site, managed from Johannesburg	online presence, informal discussions, formal interview, national workshop

Table 2: Supporting Entities Consulted, and the Sources of Primary Data

Data Ordering

The research team identified a set of descriptive variables that emerged from the data we had collected, which we clustered into a set of 12 management, spatial and activity variables, as represented in Figure 1 below. In the course of our data collection—looking at the ways in which the communities presented themselves online, and communicating with the communities via email and in-person—these were the 12 variables that we found arose most frequently.

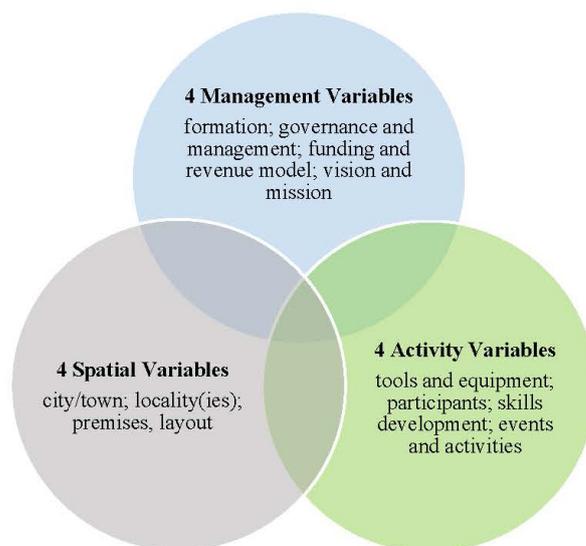


Figure 1: The 12 variables that emerged from the data

The determination of the 12 variables, and the setting out of the data according to the variables, was a descriptive exercise. The outputs from our analytical and conceptual work for this article are covered in the “Findings” and “Analysis and Conclusions” sections that follow this section. Tables outlining the descriptive data that generated the 12 variables can be found in De Beer et al. (2017), and data collected from formal interviews with eight of the Gauteng communities (referred to as

“collectives” during that stage of the research) are analysed in detail in Kraemer-Mbula and Armstrong (2017).

For the purposes of this article, it useful to reproduce, from De Beer et al. (2017), the table (see Table 3 below) providing the data for 21 maker communities in respect of the four management variables: (i) formation; (ii) governance and management; (iii) funding and revenue model; and (iv) vision and mission.

Maker Community	Formation	Governance and Management	Funding and Revenue Model	Vision and Mission
House4Hack	2011	governed and managed by member volunteers	member donations, fees from course offerings, fees from corporate partnerships	“an initiative to bring together technology specialists and entrepreneurs in an informal setting [...] trying to combine concepts from hackerspaces and innovation incubators” (www.house4hack.co.za/about)
BinarySpace	2012	governed and managed by member volunteers	member donations, membership fees, fees from course offerings, corporate sponsor	“a space where people with common interests in technology, science and electronic art, can meet, socialize and/or collaborate” (www.binaryspace.co.za)
Tinker Space, University of Johannesburg (UJ) Resolution Circle tech hub	2013	governed and managed by university-owned company	funded by university-owned company	Resolution Circle, of which Tinker Space is part “is a technology ecosystem that commercialises technology and develop engineering skills” (www.facebook.com/pg/ResolutionCircle)
Makerlabs	2013	governed and managed by member volunteers	member donations, membership fees, fees from course offerings	community “of makers, of open software (opensource) and open hardware. Home to 3D printing, Repraps, electronics, Arduino, RaspberryPie, Python and a bit of beer brewing” (www.meetup.com/en-AU/Makerlabs-co-za)

Geekulcha Makers	2014	governed and managed by paid Geekulcha staff	project partnerships with governments (foreign, national, provincial, local), private sector, universities, schools	“enables Digital Makers with tools, innovation platforms and a network for collaboration and co-creation [...] to stimulate the notion of More Consumers than Producers [...] building the world we want to see. It’s about Collaboration and Co-creation” (http://makers.geekulcha.com/about)
Sebokeng FabLab, Vaal University of Technology (VUT) tech hub	2015	governed and managed by the university	university funds, membership fees	“enable grassroots inventions by providing a platform where communities can have access to advanced tools that can help people make products to address local needs” (www.vut.ac.za/fablab/)
University of Pretoria (UP) MakerSpace	2015	governed and managed by the university	university funds	“a creative laboratory where people with ideas can get together with people who have the technical ability to make these ideas become a reality” (www.library.up.ac.za/makerspace)
eKasi Lab Ga-Rankuwa	2015	governed and managed by government (provincial and local)	government funds (provincial and local)	“take innovation to the people by establishing co-creation and innovation spaces in the townships where local communities are able to access the services and facilities [...] for the community and unemployed youth so that employment is created in their area of residence through skills and enterprise development” (www.facebook.com/pg/ekasilabs)
I Make Makers Lab, Makers Village	2015	governed and managed by non-profit foundation	proceeds from Makers Village (design and production services craft sales, restaurant, entertainment venue), funds from government, private sector	“the perfect place to gain skills on digital fabrication. Whether you use it as an individual, or in a workshop through your school, or as an inventor or entrepreneur, it helps you put your dreams and ideas into real [life]” (www.facebook.com/pg/imakersvillage)
Made In Workshop		governed and managed as a private business	membership fees, sale of consumables, proceeds from training offerings	“a shared fabrication studio and makerspace. We provide access to tools and industrial machines to people and business who would normally not have access to such facilities” (http://madeinworkshop.co.za)

eKasi Lab Soweto		governed and managed by government (provincial and local)	government funds (provincial and local)	“take innovation to the people by establishing co-creation and innovation spaces in the townships where local communities are able to access the services and facilities [...] for the community and unemployed youth so that employment is created in their area of residence through skills and enterprise development” (www.facebook.com/pg/ekasilabs)
Kluyts MakerSpace	2012	governed and managed as a non-profit by Eden Community Initiative; also linked to a private business (Kluyts & Co. furniture store)	space rental fees	“We celebrate artists, craftsmen and product makers. We believe communities add value in workshops and real economies are built on building things of value. We enable makers by networking, equipping, resourcing and supporting them in a collaborative space” (www.facebook.com/pg/kluytsmakerspace)
Craft and Design Institute (CDI) Product Support Space	2013	governed by multistakeholder CDI Board, managed by paid CDI staff	government funds (national, provincial, local)	The CDI is “a craft and design sector development agency with a mission to develop capable people and build responsible creative enterprises trading within local and international markets” (www.thecdi.org.za/?page=about_us) The CDI Product Support Space is “an assisted DIY facility empowering and helping craft producers, designers, students, and other individual businesses to develop new, and refine existing product” (www.thecdi.org.za/?page=dev_product)
Workspace	2013	governed and managed by non-profit organisation	start-up funding from the British Council’s Maker Library Network (MLN), project partnerships with local NGOs, donations, membership fees, space rental fees	“a platform for knowledge and skills exchange across the social, cultural and generational divides [...] resources for all people from all backgrounds, ages and abilities to use “making” as a tool for empowerment, economic opportunity and the building of social capital [...] a creative space for makers to engage, make and display their crafts” (www.workspace.org.za/about)
The Bank	2014	governed and managed as a private business	member donations, membership fees, space rental fees	“contemporary design space promoting innovation, collaboration, mentorship, idea exchange and business development” (www.wdcapepetown2014.com/projects/project/464)
Maker Station	2014	governed and managed as a private business	user fees, membership fees, rentals, workshops, training, events	“a shared Maker, DIY, Hacker, Hobbyist, Designer, Prototyping, Art, Craft, and creative space, to build your projects of any size” (www.facebook.com/pg/makerstation.co.za)

Modern Alchemists, Women in Tech Cape Town, and Arduino Cape Town (all coordinated by KATO Technology)	2014	governed and managed by KATO Technology (a private business)	project partnerships, member contributions	Modern Alchemists: “Anyone that is into coding, gaming, electronics, music, making, etc come to these meetups to meet like minded people, skill swop, learn, make, watch, ask for advice” (www.linkedin.com/in/robynfarah) Women in Tech Cape Town: “a community designed to empower females who are in tech or want to learn more about tech” (www.kato.global/wit)
University of Cape Town (UCT) Maker Society	2015	governed and managed by students	member contributions	“aims to connect multiple disciplines across the university in creating and inventing together. We focus on workshops, build days and exhibitions designed to help students grasp the practical aspect of building and designing” (www.facebook.com/pg/UCTmakersociety)
The MakerSpace		hybrid: governed and managed by member volunteers alongside a private business	hybrid, including donations, start-up funding from the British Council’s Maker Library Network (MLN), membership fees, member donations, fees from course offerings, aligned commercial projects and services.	“is about lowering the barriers of entry for people to express their creativity in a physical way. It is about people getting together, working creatively, inspiring each other, engaging with new technology, and building a ‘bottom-up economy’ “ (http://themakerspace.co.za/what-we-are-about)
Bloemfontein FabLab, Central University of Technology (CUT) tech hub	2006	governed and managed by the university	university funds	“enable grassroots inventions by providing a platform where anyone can have access to advanced tools that can help people make products to address local needs [...] peer-to-peer learning which enables anyone with or without a technical background to learn and have a space to experiment” (www.cut.ac.za/fablab)

Table 3: Data for the four management variables

Source: De Beer et al. (2017)

In Table 3 above, it is the data for the “governance and management” and “funding and revenue

model” variables that are of particular relevance to this article. In these two columns of the table, one can see substantial diversity in the paths being followed by South Africa’s maker communities. There are many potential lenses through which one can seek to analyse these dimensions. At a broad level, as we have argued in De Beer et al. (2017), one needs to view the data for these two variables, and the other 10 variables, through a lens of sustainability. In this article, we focus on a sub-

dimension within considerations of sustainability: possible the impacts of institutionalisation, including its potential impacts on the ethos of informal innovation.

The analytical work to produce the findings, analysis and conclusions presented in the next two sections of this article has both deductive and inductive elements. We deduce the extent and dynamics of both institutionalisation and informal innovation in terms of our chosen conceptual frameworks (outlined earlier) for these two dimensions. At the same time, in a largely inductive fashion drawing on elements of situational analysis and grounded theory-building, we interrogate the degree to which increased institutionalisation is proving to be compatible with the communities' informal-innovation dynamics.

FINDINGS

Growing Institutionalisation of the Maker Communities

When the maker movement took hold in South Africa in 2011, the pioneer was House4Hack in Centurion (Tshwane). House4Hack was established as a loosely-organised, club-like, largely non-institutionalised grouping of tech enthusiasts and hobbyists. House4Hack in turn spawned two other communities with a similarly non-institutional, club-like orientation, BinarySpace in Vanderbijlpark and Makerlabs in Johannesburg. And in class terms, all three of these spaces began as, and still largely are, middle-class in their membership and based in middle-class suburbs in their respective cities. Thus, in its beginnings, the South African movement was largely non-institutional and, at the same time, largely middle-class.

Today in early 2018, the South African maker movement is significantly more diverse, in several respects, than it was at its origins roughly seven years ago. Many of the newer communities are significantly more institutionalised than House4Hack, BinarySpace and Makerlabs, and also

much less middle-class-centric. To some developed-world readers, this correlation between increasing institutionalisation and increasing class diversity among users may seem counter-intuitive; but in the South African context, this correlation is not particularly surprising, due to conditions described below.

- Growing institutionalisation of South African maker communities is apparent in respect of each of the three institutionalisation modalities in our conceptual framework as outlined earlier in this article:
- formalisation of maker communities' practices;
- partnerships between the maker communities and formal organisations; and
- embedding of the maker communities in formal organisations.

Formalisation of Maker Communities' Practices

Fees for Membership, Use, Training and Space Rental

Several of the South African maker communities in existence today have membership-fee structures, including Made In Workshop, the DIZ MakerSpace, and Makerlabs (all in Johannesburg); BinarySpace in Vanderbijlpark; and Maker Station in Cape Town (interviewees 1, 2 and 5, 2016).

There are also maker communities that charge user fees for use of certain tools and facilities, including Made In Workshop in Johannesburg and Maker Station in Cape Town. Some communities, including House4Hack, charge fees for certain training programmes they provide (an illustration of the fact that even the club-like, hobbyist-oriented, founding South African maker community, House4Hack, is more institutionalised than it was at its establishment.) Another element of formalisation found in some South African maker communities is space rental/leasing. Communities charging rental fees to enterprises working out of their premises include Maker Station and Workspace in Cape Town,

Kluyts MakerSpace in Knysna, and House4Hack in Centurion (which had one on-site enterprise paying rent at the time our data collection).

Links to Formalised Market Opportunities

Several of South Africa's maker communities prioritise links to formalised market opportunities, including I Make Makers Lab in Irene (Tshwane), Kluyts MakerSpace in Knysna, the DIZ Maker Space in Johannesburg, and House4Hack in Centurion (interviewees 15 and 21, 2016). The I Make Makers Lab is situated within an entity called Makers Village, and one of the aims of the Village is to bring informal-sector artisans into contact with formalised marketing opportunities. Artisans linked to the Village are able to: sell products via the Irene Trading Post store at the Village; sell services and products to clients procuring fabrication services from the Village; and sell services and products to the Village's restaurant and entertainment venue, the Railways Café. At the Kluyts MakerSpace in Knysna, the space is twinned with the Kluyts and Co. wooden furniture store, which provides the enterprises who rent space in the MakerSpace with opportunities to supply services and products to Kluyts and Co. clients. At the DIZ Maker Space in the University of the Witwatersrand (Wits) Tshimologong Precinct in Johannesburg, the space is coordinated by a private company, African Robot, which produces items on a commercial basis in addition to managing the space and providing training and facilitation to member users.

Formation of a National Association

There are also elements of formalisation in evidence in the efforts of South African makers to organise themselves at national level via an association. The association, which first began to take shape in early 2016, is the South African Maker Collective. At the time of the South African Maker Movement Workshop we convened in Pretoria March 2017, the Collective was still nascent, and largely being driven by The MakerSpace in Durban (which provided both in-person and video presentations to the March

2017 workshop). The workshop brought together Collective members from Gauteng Province (Johannesburg, Pretoria, Vanderbijlpark), Cape Town and Durban who do not often have opportunities to meet face-to-face. We gave control of the late-afternoon session of the one-day workshop to the Collective, so that it could facilitate breakaway sessions that generated ideas for how the South African movement could operate at local, provincial, national and international levels. Later that same month of March 2017, a leader in the Collective sent out an email message to all workshop attendees asking attendees: to give inputs on a written record of the meeting's outcomes; to provide information about their work; and to consider formalising their membership in the Collective. That email stated that:

[w]e are excited to get The South African Maker Collective up and running more formally. [...] The idea of the collective is to minimize admin on makers while maximising their impact, influence and access to resources. (South African Maker Collective, 2017)

In early 2018, as this article was being finalised, another Collective member sent out an email, to the Collective's national email list, entitled "SA Makers Collective formalization: Draft Constitution doc & Maker weekend planning" with the draft Constitution attached and a message reading as follows:

I encourage, urge and implore you to have a read through our DRAFT of a Constitution Document for the Collective, and share your input, suggestions and critique - it's a COLLECTIVE, after all. The aim of this document is to ultimately represent us as the SAMC so we can register the Collective as a legal entity within the next 3-6 months [...] and run it full-time as our "Industry body" - the objectives WHY are in the document. ;-). (South African Maker Collective, 2018b)

Among the objectives of forming a formalised

Collective, as stated in the draft Constitution, are the creation of “a contact point” the country’s maker communities”, building the “credibility” of the national maker “network”, providing a “collective bargaining” dimension, sharing knowledge, collaborating, engaging in collective fundraising, and engaging in collective community/social responsibility activities (South African Maker Collective, 2018a).

Partnerships between Maker Communities and Formal Organisations

Partnerships with South African Government Entities

Several of the maker communities have substantial partnerships with government entities. Geekulcha, the umbrella initiative under which the Geekulcha Makers project falls, partners with national government, the Gauteng Provincial Government, the Northern Cape Provincial Government, the City of Tshwane, and the City of Johannesburg. The Craft and Design Institute in Cape Town, under which the CDI Product Support Space falls, has funding partnerships with local, provincial and national government. Among the I Make Makers Lab’s multiple partnerships are an equipment support partnership with the national Industrial Development Corporation (IDC) and a training partnership with the state- and industry-funded national Sector Education and Training Authority (SETA) for Media and Information and Communication Technology (the MICT SETA). Meanwhile, the DIZ Maker Space partners with the City of Johannesburg on annual #Hack.Jozi Challenge hackathons. This desire by government entities to partner with South African maker communities was also apparent in the participation, in the March 2017 South African Maker Movement Workshop in Pretoria, by representatives of the national Department of Science and Technology (DST), the aforementioned national IDC, and the aforementioned Gauteng-Government-led Innovation Hub.

At the same time, even with all of the existing partnerships between the maker communities and

government entities, there was a view expressed at the Maker Movement Workshop that government entities need to be more proactive in seeking partnerships with makers, most of whom lack experience in dealing with government funding and procurement modalities. In the words of one of the DIZ Maker Space presenters who spoke at the workshop:

The trouble we have is how do we actually take it to the next step? [...] Ok great, like, come up with this big proposal [to government], but that’s not what we’re good at. We are good at making, we are good at inventing, we are good at hardware. We are geeks. We need support from government, to say “This is what we need, our ROI [return on investment] is x, y, z. How can you guys help establish that?” (DIZ Maker Space, 2017)

Partnerships with Schools

Several South Africa’s maker communities partner with schools in order to give school children access and exposure to maker tools and techniques. Making is viewed, by the maker communities and schools alike, as a powerful vehicle for building of science, technology, engineering and mathematics (STEM) skills, and science, technology, engineering, art and mathematics (STEAM) skills. In the words of one of the makers interviewed at the South African Maker Movement Workshop in Pretoria:

I think in terms of the maker movement in the South African context, education [...] comes to the forefront. I think our education system needs to change drastically, and I think the maker movement is an absolute shining light in this sector. (interviewee 30, 2017)

Maker communities that have partnered with schools include Geekulcha Makers, DIZ Maker Space, I Make Makers Lab, and House4Hack.

Partnerships with Foreign Government Entities

The UK-Government-funded British Council, through its international Maker Library Network (MLN) initiative, has partnered with several South African maker communities, by providing initial start-up funding and resources. MLN supports provision by maker communities of a makerspace, a maker library, and a gallery to display and sell maker products, and each MLN maker community is given linkages to other communities in the global MLN movement. South Africa maker communities that have partnered with MLN include Durban's The MakerSpace, Cape Town's The Bank, Workspace in Hout Bay, and Geekulcha in Tshwane. Geekulcha has also partnered on some of its training with the US State Department, and the UP MakerSpace has partnered with a US Agency for International Development (USAID) programme, ResilientAfrica Network (RAN), for UP student innovation competitions.

Partnerships with Private-sector Bodies

Geekulcha frequently partners with private-sector firms in delivery of its programmes. House4Hack sometimes hosts innovators sponsored by the South African Breweries Foundation (SAB Foundation) Social Innovation Awards Programme. Made In Workshop has partnerships with some of its equipment suppliers.

Partnerships with the Non-profit Sector

One of the maker communities we studied—the I Make Makers Lab—is embedded in a non-profit entity governed by a foundation. We also identified interest from certain small-enterprise-support NGOs in partnering with maker communities in incubating innovative enterprises. Representatives from two such NGOs, Awethu Project and The Hope Factory, participated in the South African Maker Movement Workshop in Pretoria in March 2017.

The South African Maker Collective's Openness to Partnerships

A March 2017 email message from the South African

Maker Collective to participants in that month's national workshop in Pretoria proposed five possible "membership levels" for the Collective, as follows:

- Founder members – Key members responsible for the formation of the collective
- Organisational Members – Maker Spaces, Hacker Groups, Universities, Clubs, etc
- Partners – Sponsors, brands, companies making a financial contribution
- Members – Regular makers supporting the cause
- Associated Members – people sitting on the fence not currently willing to contribute. (South African Maker Collective, 2017)

Here in this proposal for consideration of "Sponsors, brands, companies making a financial contribution" as potential "Partners" with membership status in the Collective, we see the Collective's apparent openness to private-sector institutional linkages.

Partnership with the Open AIR network

A partnership of some sort has emerged between members of the South African Maker Collective and Open AIR research network. The South African Maker Collective includes one of the Open AIR South Africa maker team members (who is also one of the authors of this article) in the Collective's email list, thus keeping Open AIR abreast of the Collective's activities and offering the Open AIR the opportunity to input on the Collective's documents, including the aforementioned February 2018 South African Maker Collective draft Constitution. (Open AIR has to date chosen not to input on the documents shared by the South African Maker Collective.) As well, both before and after the Pretoria workshop of March 2017, one of the maker communities in the Collective proposed ideas for more formal partnerships in the future with Open AIR on research, advocacy and policy engagement matters. Following the Pretoria workshop, the Open AIR Egypt researcher team invited one of the drivers of the South African Maker Collective to participate in its own workshop in Cairo. It is probable that the introductions made

during and around that workshop could also lead to collaborations, perhaps even partnerships, between South African makers and Open AIR researchers (and makers) in Kenya, Ghana, Canada, and elsewhere.

Embedding of Maker Communities in Formal Organisations

Embedded in Government Entities

Maker communities fully embedded in government structures include the eKasi Labs of Ga-Rankuwa (Tshwane) and Soweto (Johannesburg) and the FabLabs of the City of Ekurhuleni (next to Johannesburg). The eKasi Labs are co-creation, innovation and entrepreneurship hubs funded by the Gauteng Provincial Government's Innovation Hub. eKasi Lab Ga-Rankuwa is housed in the Ga-Rankuwa Arts and Crafts Centre, which is owned and run by the City of Tshwane. The maker collective is housed in the Manufacturing section of the Centre. (The Centre used to be craft-focused but is now a multipurpose municipal facility, with the eKasi Lab as the anchor initiative.) The Soweto eKasi Lab is housed in the Soweto Empowerment Zone, an entrepreneurship support hub owned and run by the City of Johannesburg. The maker activities at that eKasi Lab, still at only their very early stages at the time of the data collection, are in the eKasi Lab's FabLab room.

Partially Embedded in a Government Entity

Another maker community, Geekulcha Makers, is headquartered at the Gauteng Provincial Government's Innovation Hub in Tshwane, but in many respects it is not truly embedded in the Innovation Hub. The Geekulcha Makers community, part of a suite of Geekulcha programmes, funds its activities through a wide range of partnerships with entities outside of the Gauteng Government, and conducts most of its activities away from the Innovation Hub.

Embedded in a Government-funded Entity

The CDI Product Support Space is a unit of the larger Craft and Design Institute (CDI), which is government-funded (with national, provincial and local government funds) but governed by a multistakeholder Board that includes non-government members.

Embedded in Universities

One collective is embedded in a university campus: the UP MakerSpace housed in the Merensky Library on the Hatfield Campus of the University of Pretoria (UP). The UCT Maker Society was also embedded in a university, the University of Cape Town, but disbanded in the second half of 2017 due to the core members graduating.

Embedded in University-linked Technology Hubs

Several of the communities are embedded in university-linked tech hubs. Johannesburg's DIZ Maker Space is situated in the Tshimologong Digital Innovation Precinct, a development spearheaded by Wits University in partnership with government and private-sector partners. The University of Johannesburg (UJ) Tinker Space is in UJ's Resolution Circle tech hub; the Sebokeng FabLab is part of the Vaal University of Technology (VUT) Southern Gauteng Science and Technology Park; and the Bloemfontein FabLab is part of the Central University of Technology (CUT) Science Park.

Embedded within Non-profit Foundation Entity

The I Make Makers Lab is embedded in the Makers Village in Irene (Tshwane)—but with the I Make mobile lab allowing the I Make project to also operate in locations away from the village, including rural locations very far from Irene, in Limpopo, Mpumalanga and KwaZulu-Natal Provinces. The I Make Makers Lab project, as with the entire Makers Village, is governed by a non-profit foundation and funded from a range of sources.

We now turn to our findings in respect of the maker communities' informal-innovation modalities.

The Maker Communities' Orientation towards Informal Innovation

We found numerous examples in the data of maker community adherence to all five of the modalities in our informal-innovation conceptual framework:

- constraint-based innovation;
- incremental innovation, i.e., adopting, adapting and improving of available ideas, practices, technologies to solve problems;
- collaborative innovation;
- informal approaches to knowledge appropriation; and
- innovation in informal networks or communities in informal settings, i.e., either physical (e.g., clusters) or virtual (e.g., online) networks/communities.

Constraint-based Innovation

The makers we interviewed made frequent reference to a strong tradition, in South Africa, of innovation in response to constraints. In the words of a member of the DIZ Maker Space, "I do think true innovation happens [...] out of necessity, and I think South Africa has a lot more of that necessity than, say, places in Europe (interviewee 1, 2016). Several interviewees made reference to the Afrikaans-language saying "'n Boer maak 'n plan" ("A farmer makes a plan"), referring to the perceived tradition in South Africa of responding to scarcity by making do with what one has at one's disposal. As one interviewee explained:

[...] we don't have the broad population having the kind of luxury of living in the so-called "First World conditions" where everything is organised. And therefore, you know, we have a saying in Afrikaans, which says "'n Boer maak 'n plan". [...] And if I could tell you some of the stuff my father did [...] He was a maker of note, he was an improviser, because we didn't have much financial means [...] We lived on a small farm [...] I could [tell] you stories about his

inventions and maker talent that could keep you busy for a long time. (interviewee 23, 2016)

In the words of another maker, who presented at the South African Maker Movement Workshop in Pretoria:

The significance of making in the South African context is that it's just part of who we are. We need to find ways to solve problems, we need to find the path of least resistance, because either we don't have resources, or we don't have the time, or we don't agree with the way it's being done formally. So, we make a plan. We're inventive, resourceful, that way, and if you don't have everything at your disposal, you figure out how to do it with what you have. (interviewee 32, 2017)

The low-cost Morgan 3D Printer, developed by a member of the House4Hack collective, seems clearly to be an innovation born of constraint. It is a "rep rap" (replicating rapid prototyper) printer that can largely self-replicate by printing most of the parts needed to assemble a copy of itself. According to interviewee 21 (2016), a key motivation for development of this printer was that imported 3D printers were initially prohibitively expensive in South Africa, thus prompting the developer to make a product that could "put a high-quality machine into the hands of [South African] makers" at an affordable price.

Two of the makers who attended the Maker Movement Workshop spoke of their innovations as driven by adversity. The first, a student doing his making at the UP MakerSpace, spoke of how his alternative-energy-production innovation is grounded in the need to address electricity-access challenges facing many South Africans (interviewee 31, 2017). Another innovator, working out of the DIZ Maker Space, spoke of how his "smart pavement" brick innovation aims to help South Africans prevent household crime by being alerted, via sensors in bricks, to unusual activities in their driveways (interviewee 33, 2017). In the words of one of the

Geekulcha presenters at the Pretoria workshop, “at the end of the day, we need to step up to national problems. We need to step up to the needs” (Geekulcha, 2017).

Incremental Innovation

We also found a strong ethos of incremental innovation among the makers interviewed. As one member of the Makerlabs collective in Johannesburg explained, “I don’t think as a maker that there’s anything really that you are doing that’s, like, brand-spanking-new [...] there’s something very similar out there. You’ve just got a different twist on it (interviewee 20, 2016). A House4Hack interviewee exemplified the spirit of incremental innovation when describing House4Hack’s PiScope project, through which the collective built an astrophotography unit using parts of a telescope, a Raspberry Pi, and a Raspberry Pi Camera. “It has been done before, so I wouldn’t say it’s like unique”, the interviewee said, but “it hasn’t been done in the way we are doing it, and we’ve come up with great ideas of what it can do that [have] never been tried before” (interviewee 15, 2016).

Several respondents spoke of South Africans’ talent for incremental innovation grounded in recycling and re-purposing of existing items. In the words of one interviewee, “we [South Africans] basically take technology, whether it’s cutting edge or not, and we repurpose it” (interviewee 15, 2016). According to another: “To a real maker, something broken isn’t broken, it’s just parts for a new project, and definitely that has a huge, huge impact [...] recycling [is] very much a big part of it” (interviewee 1, 2016). Another maker put it this way: “in the South African context [...] using some of the recyclable materials and all that, we just can come up with new [ideas] and build some of the new things” (interviewee 4, 2016).

Collaborative Innovation

We also found frequent reference to the power of collaboration—as an engine of innovation, and of learning and skill-sharing. In the words of a maker in

the BinarySpace collective in Vanderbijlpark,

[f]or a lot of guys, the reward is the learning experience, especially for me. I don’t mind helping you with something. I don’t mind even developing your whole project for you. Because for me, learning something out of it, is the goal, or, is the reward. (interviewee 7, 2016)

As an interviewee from the DIZ Maker Space explained it, “the most connecting thing is this idea of sharing knowledge, and I think that you can almost tell immediately when you meet with someone whether they have that kind of mindset or not” (interviewee 1, 2016). Another DIZ Maker Space member, in his presentation to the Pretoria workshop, described the workings of collaborative innovation in makerspaces in the following terms:

Just to be in that environment, you know, where ideas are shared every day, where you collaborate on so many things, we found it to be quite helpful. [...] We came into the space with an idea, you know, but what we are now is totally different. Because somehow guys have helped us shape what we are doing and what we are about. (DIZ Maker Space, 2017)

Informal Approaches to Knowledge Appropriation

We found that respondent attitudes towards knowledge appropriation also largely fit with the assumptions in our informal-innovation conceptual framework. The vast majority of interviewees made statements suggesting they saw little or no value in attempts at formalised knowledge appropriation via tools such as patents or copyrights. Interviewee 4 (2016), when describing the innovations Geekulcha has developed in respect of installing tracking devices into skateboards, and teaching high school students to do the same via its “SkateHack” programme, spoke of the skateboard-tracking as an “open idea”. He stated that, when introducing the idea to students, “it was a new idea to them, so it

was just like a ‘wow’ thing. [...] It was [...] an open idea, so everybody who’s willing to actually build a skateboard like that [...] can actually build it as well.”

Another example of a lack of concern with formal appropriation emerged from the interview with interviewee 15 (2016), from House4Hack. He told this anecdote about House4Hack winning two competitions with a remote-control innovation:

A lot of people came to us and said, like, “okay, so have you patented this thing, are you gonna sell it?” [...], and I was like, “you know what, all the code is on [...] an open source repository. You can go and download it, and you can go make it yourself, and you can go sell it. Go have fun” [...] I had zero interest in trying to build a company out of this.

According to another House4Hack member (interviewee 14, 2016), making and formalising intellectual property do not fit well together, because, he said, making is based on a “philosophy of generosity, of giving”, rather than a “scarcity mentality”. He said that “we sometimes do get people that come here with the scarcity mentality, and how you identify them is the first thing they want you to do is sign an NDA [non-disclosure agreement]. And then pretty much at that point, we can tell them to go away, [...] that’s not who we are.”

An interviewee from BinarySpace in Vanderbijlpark stated his belief that seeking a patent for an innovation can become a “barrier” because of the cost and time involved. He and colleagues at BinarySpace agreed that the key goal of a small-scale innovator seeking to commercialise something needs to be getting the product to market as soon as possible, not worrying about the innovation being copied. Often much of the economic value, they felt, will come not from selling the product but from boosting one’s reputation and from the ability to charge for servicing the product (interviewees 5-8, 2016). An interviewee from House4Hack, who

developed a low-cost 3D printer that he now manufactures on a small scale and sells, said he never had an interest in patenting the design and had made the design specifications freely available online. His said his view is that as soon as one seeks to keep a product innovation secret, or to patent or copyright it, one merely draws unhelpful attention to the innovation from people who may then seek to copy and commercialise the same product or something very similar (interviewee 21, 2016).

An interviewee from the DIZ Maker Space portrayed South African makers’ approach to knowledge in this way:

Especially in the past, they were like “this is my idea, but I mustn’t share it because then that guy is just going to take it and make money off it”. Whereas the big change is in like “cool I just figured out how to do this completely new thing, hey, let me show you and then you can do it because you might discover something that I wouldn’t because your background’s slightly different, then you’ll share that back to me”. (interviewee 1, 2016)

Innovation in Informal Networks/Communities in Informal Settings

We found that several of the communities had forged strong links to grassroots innovators operating in low-income, informal settings. For example, at eKasi Lab Ga-Rankuwa, the entrepreneurs we interviewed had all begun as grassroots, informal innovators, and had entered the Lab’s innovation incubation and commercialisation programme (funded by the Gauteng Government’s Innovation Hub) in response to a public call for applications that had been circulated in Ga-Rankuwa, a low-income community. We also saw evidence at eKasi Lab Soweto, which had only recently been established at the time of our visit, of connection with low-income, informal-sector innovators. And Geekulcha has forged links to the grassroots through, among other things, its work with informal-sector entrepreneurs at eKasi Lab Ga-

Rankuwa (interviewee 3, 2016).

Workspace in Hout Bay (greater Cape Town) has strong links to people, particularly youth, living in Hout Bay's low-income informal settlements. Workspace's outreach to the local youth is via a project it calls The Employable Nation (TEN). The TEN programme seeks to build a set of 10 skills seen as necessary to increased employability, with the skills built through participants engaging in projects ranging from cooking and jewellery-making to welding and woodworking. Another Cape Town-area maker community, Maker Station, has also forged links with low-income, informal-sector innovators, through offering low-cost access to tools applicable to a wide range of fabrication methods (including both digitally-mediated and analogue methods).

The I Make Makers Lab has a strong focus on linking with innovation by grassroots craftspeople from low-income areas (interviewee 18, 2016). The I Make mobile unit is used to work with rural craftspeople in Limpopo, Mpumalanga, and KwaZulu-Natal Provinces (interviewee 18, 2016). According to an I Make interviewee: "Basically, we run a pilot project to obtain the data to see how we can influence job creation in South Africa, by putting together really informal [...] individuals from various areas in South Africa with technology within the Makers Lab" (interviewee 29, 2017).

We also found that three of the maker communities embedded in university-led tech hubs—DIZ Maker Space, Sebokeng FabLab and Bloemfontein FabLab—are managing to draw in informal-sector innovators from nearby low-income townships. And Kluyts MakerSpace in Knysna is tapping into that town's informal-sector woodworking innovators.

ANALYSIS AND CONCLUSIONS

Gradations of Institutionalisation

While the overall trend in the South African maker movement is towards greater institutionalisation, it must at the same time be emphasised that there is

significant diversity in the communities' degrees of institutionalisation.

At the lowest level of institutionalisation sit BinarySpace in Vanderbijlpark and Makerlabs in Johannesburg, both of which continue to operate largely as they operated at their inception: as small, club-like groupings of hobbyists. Apart from charging nominal membership fees, these two communities exhibit very little institutionalisation. The evidence we collected suggests that these two maker communities will seek to remain largely non-institutionalised.

The BinarySpace representative who attended the Maker Movement Workshop in Pretoria in 2017 stated clearly, during plenary discussions, that BinarySpace did not want to dilute its non-institutional ethos, and that there should not be attempts by the national movement to create a one-size-fits-all model for maker communities (BinarySpace, 2017). BinarySpace's attitudes towards institutionalisation may have been coloured by an experience that one of its members described during our 2016 interviews—an experience wherein partnership talks between BinarySpace and a local tertiary institution broke down because the institution appeared to be setting too many conditions for the partnership.

The other still-largely-non-institutional maker community, Makerlabs, also seems to be determined to remain largely free of institutional modalities. In 2017, Makerlabs tried a model whereby its weekly meet-ups were held at Made In Workshop, which is in the same suburb of Johannesburg (Randburg) as the location of Makerlabs meet-ups but which is much more institutionalised. (Made In Workshop is modelled on the US TechShops, providing membership-fee-based and user-fee-based access to extremely high-quality fabrication equipment.) By the end of 2017, Makerlabs had reverted to its original model, holding its meetups in much-less-institutionalised, and much-less-well-equipped premises—an apparently strong testament to the incompatibility of the

Makerlabs ethos and a more institutionalised ethos.

Sitting very near to BinarySpace and Makerlabs on the non-institutionalised end of the institutionalisation continuum is the founding South African makerspace, House4Hack, which shares many of the club-like, hobbyist traits of BinarySpace and Makerlabs—which is unsurprising given that BinarySpace and Makerlabs were started up by former House4Hack members. But House4Hack has, in recent years, introduced some clear institutional features that are not present in its two offshoots. House4Hack has a fee-based training programme; it rents space to a 3D-printer-making business; and it hosts innovation interns via a funded arrangement with the South African Breweries social responsibility unit.

Sitting near the fully institutionalised end of the institutionalisation spectrum are the eKasi Labs of Ga-Rankuwa and Soweto, the UP MakerSpace, Made In Workshop, and the CDI Product Support Space. The eKasi Labs are government-funded and hosted in government-owned facilities, and the participants in their programmes are aspiring innovators who have applied, and been selected for, incubation support from the Gauteng Provincial Government's Innovation Hub. The UP MakerSpace is housed in a University of Pretoria Library, managed by university employees, staffed by university students paid by the university, and is accessible only to university students. Made In Workshop is a private business following a model akin to a US TechShop franchise, providing access to high-end equipment and professional support to paying members. The CDI Product Support Space is part of the broader Craft and Design Institute, which, though governed by a multistakeholder board including non-government representatives, is to a great extent accountable to government by virtue of receiving funding from local, provincial and national government. We see all of these maker communities as highly institutionalised because they meet at least two of our institutionalisation criteria: formalisation of practices, partnerships with formal organisations, embedding in formal organisations.

Also highly institutionalised are the maker communities embedded in university-led tech hubs: the DIZ Maker Space, the Tinker Space, the Sebokeng FabLab, and the Bloemfontein FabLab. All of these communities meet the embeddedness criterion in our institutionalisation framework, and tech hubs are by their very nature based on partnerships among formalised entities. Thus all of the maker communities working out of university-led tech hubs meet two of our three institutionalisation criteria: embeddedness and partnerships. And the DIZ Maker Space also charges nominal user fees, thus meeting our other institutionalisation criterion: formalisation of practices.

For all of the other maker communities from which we used data in our findings and analysis, it was difficult to know where to place them on the institutionalisation continuum. And this we came to regard as a key strength of the South African maker movement in its present stage of evolution. There are at present myriad models being followed, with many of the communities adopting hybridised approaches that allow them to be both somewhat institutionalised and somewhat non-institutionalised at the same time. The Geekulcha initiative, for instance, under which the Geekulcha Makers community falls, has its offices at the Gauteng Government's Innovation Hub, but Geekulcha does not behave in an embedded fashion, with most of its training and outreach projects taking place away from the Innovation Hub, in partnership with a wide range of formalised government and corporate partners. And perhaps because it has so many partnerships with so many different formalised entities, Geekulcha seems to be able to avoid institutional rigidity. And Geekulcha does not blindly accept every partnership. According to interviewee 3 (2016) of Geekulcha, the community refused an event collaboration with a software firm because the firm insisted that only its software be used at the event.

Several of the communities have found their fluid versions of institutionalisation through hybrid

funding arrangements, as shown in the “funding and revenue model” column in Table 3 above. For example, the I Make Makers Lab and Kluyts MakerSpace both operate on a non-profit basis but are twinned with initiatives that include commercial elements. Durban’s The MakerSpace runs has a mix of non-for-profit and commercial activities.

Class Orientations

We saw above in the literature review that one of the critiques levelled at the maker movement in the developed-world context is its tendency to be skewed towards serving middle-class users and interests. In the South African context, we found that only six of the 21 spaces for which we extracted findings and analysis could be categorised as middle-class-oriented: BinarySpace, Makerlabs, House4Hack, Made In Workshop, UP MakerSpace, and UCT Maker Society.

BinarySpace, Makerlabs and House4Hack all meet in privately-owned spaces in middle-class suburbs. Made In Workshop’s middle-class orientation is a function of its location in a middle-class Johannesburg suburb and its aforementioned adoption of a TechShop-style model based on membership fees and user fees. For its part, the UP MakerSpace, embedded in the University of Pretoria campus, is only mandated to the university student body, the majority of whom are from middle-class backgrounds. And the UCT Maker Society at the University of Cape Town was, before its closure in the second half of 2017, geared towards the student body which, as with UP’s student body, is largely middle-class.

With the other 15 maker communities, we identified significant latitude, and intent, to reach out to, serve, and collaborate with, innovators from a wide range of backgrounds, including low-income and impoverished innovators. And we found this outreach to be present in communities exhibiting a range of degrees of institutionalisation, including both highly-institutionalised communities (e.g., the eKasi Labs and the maker communities in

university-led tech hubs) and the myriad communities following hybridised approaches that allow a mix of institutional and non-institutional dynamics.

Thus it was only in the largely non-institutionalised category of communities—as represented by BinarySpace, Makerlabs, House4Hack—that we found an absence of class diversity in the participants. Thus it would appear that institutionalisation, as it is presently operating in the South African maker movement context, is having a positive impact on class inclusiveness.

Informal-Innovation Modalities

It could be supposed that institutionalisation modalities conflict with informal-innovation modalities, and vice versa. However, that is not what we found in the South African case. We found strong adherence to informal-innovation values and practices across all the communities from whom our data findings and analysis were drawn. The previous section of this article provided numerous examples of South African maker communities valuing and nurturing informal-innovation modalities. The examples were drawn from maker communities situated all along the continuum between non-institutionalisation and institutionalisation: from the largely non-institutionalised communities, through to the hybrid communities balancing non-institutional and institutional elements, through to the large institutional communities. Unlike class inclusiveness, which we found dropped off in certain settings, particularly non-institutional ones, we found no significant dilution of the informal-innovation ethos in any of the 21 communities on which we based our findings.

Accordingly, our conclusion is that, in the South African case, informal-sector innovation modalities in a maker community are, at present, neither significantly undermined nor significantly strengthened by institutionalisation modalities. When significant elements of institutionalisation are present in a South African maker community—as is

the case in the clear majority of the communities—the increased formality inherent in many elements of institutionalisation does not conflict with informal innovation. Rather, the two sets of modalities can co-exist, and coexist fruitfully.

At the same time, we are not suggesting that the informal-innovation ethos is generic across South African maker communities. A key distinction can be made, in our view, based on the degree to which a maker community has to date managed to forge strong links to low-income, grassroots, informal-sector innovators. In the communities with these kinds of strong links—i.e., the ones mentioned in the final subsection of the “Findings” section above (the two eKasi Labs, Geekulcha, Workspace, Maker Station, I Make, three of the tech-hub-embedded communities, and Kluyts MakerSpace)—one inevitably finds a certain number of innovators with strong livelihood needs linked to their innovation efforts. While low-income and middle-class innovators may share, as we found they do, an adherence to the informal-innovation ethos, there is no doubt that, at certain points, a low-income innovator’s objectives will diverge from those of a middle-class innovator. (The low-income innovators drawn into South African maker communities will inevitably, in our analysis, have more pronounced needs than middle-class makers at the level of socio-economic inclusion—and follow-on Open AIR research already underway is seeking to explore the socio-economic dimensions of making in the South African context.)

Formal-informal Intermediation

Many South African maker communities appear to provide clear example of the reality, as found in previous research (Kraemer-Mbula & Wamae, 2010; Kraemer-Mbula & Wunsch-Vincent, 2016) and as explained in De Beer et al. (2016), that a strong feature of innovative behaviour in African and other developing-world informal settings is synergy between informal innovative behaviour and formal-economy elements. As De Beer et al. (2016) write:

Innovations in the informal economy have various connections with the formal sector. Knowledge, skill, capital, people and other types of resources can sometimes flow both ways. (De Beer et al., 2016, p. 80)

Our findings suggest that: (i) there is a substantial, and growing, two-way flow of resources of various kinds between South African maker communities and formal-sector entities; and (ii) that both South African maker communities and formal entities see the need for these flows to continue and strengthen.

The JoPP call for submissions on “Institutionalization of Shared Machine Shops”, cited above, speaks of “[t]he dilemmas of institutionalisation” for communal fabrication communities, of which maker communities are an example. Our finding is that, in the current South African maker context, elements of institutionalisation appear to present more opportunities than dilemmas—and that South African maker communities appear to be, in general, favourable towards, and able to harness, those opportunities.

A sentiment voiced by several stakeholders at the 2017 South African Maker Movement Workshop in Pretoria was that South African maker communities need to continue to seek, and strengthen, mutually beneficial partnerships with government and other formal entities. There appears to be a clear sense that such partnerships, and other elements of institutionalisation via elements of formalisation, can be pursued in a manner that does not detract from the core informal-innovation power of making. There also seemed to be a sense, present at the workshop, that linkages between maker communities and the formal sector offer communities the potential to increasingly function as part of developmental, multi-stakeholder ecosystems in the country—ecosystems that can contribute to alleviating South Africa’s shortfalls in areas such as STEM/STEAM education, youth employment, and enterprise development.

Viewed in this manner, South Africa’s maker

communities can potentially be seen as new, emerging intermediaries in South Africa's innovation ecosystem: intermediaries between actors in the formal and informal sectors/economies. We have seen this intermediary role in other African contexts studied by the Open AIR network. Kawooya's (2014) research into the innovation dynamics of Ugandan informal-sector auto parts fabricators in Kampala identified an intermediary "semi-formal" entity, Gatsby Garage, which was a linking-point for the informal-sector artisans and staff and faculty at Makerere University. And soon-to-be-published research by our Open AIR network colleagues Oluseye Jegede in Nigeria and Yaw Adu-Gyamfi in Ghana has also found evidence of intermediary actors bridging formal and informal modalities/entities/sectors. This theme of informal-formal intermediation is potentially central to understanding the role of the maker movement in African, developing-world, and even developed-world, national innovation systems. South Africa's maker communities, we conclude, appear to demonstrate that institutionalisation dynamics in innovation settings can, and ideally should, be dynamics characterised by two-way flows, between formal and informal modalities.

REFERENCES

- Baldwin, C. & Von Hippel, E. (2011) 'Modeling a paradigm shift: from producer innovation to user and open collaborative innovation', *Organization Science*, 22(6), pp. 1399-1417.
- Benkler, Y. (2006) *The wealth of networks: how social production transforms markets and freedom*. London: Yale University Press.
- BinarySpace (2017) Inputs to South African Maker Movement Workshop, Pretoria, 3 March.
- Braybrooke, K. & Jordan, T. (2017) 'Genealogy, culture and technomyth: decolonizing Western information technologies, from open source to the maker movement', *Digital Culture & Society*, 3(1), pp. 25-46. Available at: <https://www.degruyter.com/view/j/dcs.2017.3.issue-1/dcs-2017-0103/dcs-2017-0103.xml>
- Chesbrough, H. (2006) 'Open innovation: a new paradigm for understanding industrial innovation', in Chesbrough, H., Vanhaverbeke W. and West, J. (eds), *Open innovation: researching a new paradigm*. Oxford: Oxford University Press.
- De Beer, J., Armstrong, C., Oguamanam, C. & Schonwetter, T. (eds) (2014) *Innovation and intellectual property: collaborative dynamics in Africa*. Cape Town: UCT Press.
- De Beer, J. & Armstrong, C. (2015) 'Open innovation and knowledge appropriation in African micro and small enterprises (MSEs)', *The African Journal of Information and Communication (AJIC)*, 16, pp. 60-71. Available at: <https://doi.org/10.23962/10539/19315>
- De Beer, J., Fu, K. & Wunsch-Vincent, S. (2016) 'Innovation in the informal economy', in Kraemer-Mbula, E. & Wunsch-Vincent, S. (eds), *The informal economy in developing nations: hidden engine of innovation?* Cambridge, UK: Cambridge University Press.
- De Beer, J., Armstrong, C., Ellis, M. & Kraemer-Mbula, E. (2017) *A scan of South Africa's maker movement*. Ottawa and Cape Town: Open African Innovation Research (Open AIR). Available at: <http://www.openair.za/publications/a-scan-of-south-africas-maker-movement/>
- DIZ Maker Space (2017) Presentation to South African Maker Movement Workshop, Pretoria, 3 March.
- Dougherty, D. (2012) 'The maker movement', *Innovations*, 7(3), pp. 11-14.
- Ekekwe, N. (2015) 'Africa's maker movement offers opportunity for growth', *Harvard Business Review*.

Available

at: <https://hbr.org/2015/05/africas-maker-movement-offers-opportunity-for-growth>

Geekulcha (2017) Presentations to South African Maker Movement Workshop, Pretoria, 3 March.

Hatch, M. (2014) *The maker movement manifesto: rules for innovation in the new world of crafters, hackers, and tinkerers*. New York: McGraw Hill. Available at: <http://www.techshop.ws/images/0071821139%20Maker%20Movement%20Manifesto%20Sample%20Chapter.pdf>.

Hersman, E. (2013) 'The need for both makerspaces and incubators in Africa' *Ventureburn*. Available at: <http://ventureburn.com/2013/02/the-need-for-bot-h-makerspaces-and-incubators-in-africa/>

Journal of Peer Production (JoPP) (2017) 'The institutionalization of shared machine shops: new spaces, networks + practices', *JoPP*, 12. Available at: <http://peerproduction.net/cfp-jopp-special-issue-12-the-institutionalization-of-shared-machine-shops-new-spaces-networks-practices/>

Kawooya, D. (2014) 'Informal-formal sector interactions in automotive engineering, Kampala', in De Beer, J., Armstrong, C., Oguamanam, C. & Schonwetter, T. (eds). *Innovation and intellectual property: collaborative dynamics in Africa* (pp. 59-76). Cape Town: UCT Press.

Kraemer-Mbula, E. (2016) 'Informal manufacturing of home and personal care products in South Africa' in Kraemer-Mbula, E. & Wunsch-Vincent, S. (eds), *The informal economy in developing nations: hidden engine of innovation?* Cambridge, UK: Cambridge University Press.

Kraemer-Mbula, E. & Wamae, W. (2010) 'Adapting the innovation systems framework to Sub-Saharan Africa', in Kraemer-Mbula, E. & Wamae, W. (eds), *Innovation and the development agenda*. Paris and Ottawa: OECD and IDRC.

Kraemer-Mbula, E. & Wunsch-Vincent, S. (eds) (2016) *The informal economy in developing nations: hidden engine of innovation?* Cambridge, UK: Cambridge University Press.

Kraemer-Mbula, E. & Armstrong, C. (2017) *The maker movement in Gauteng Province, South Africa*. Ottawa and Cape Town: Open African Innovation Research (Open AIR). Available at: <http://www.openair.org.za/wp-content/uploads/2017/06/WP-6-Maker-Movement-in-Gauteng-Province-South-Africa.pdf>

Lorinc, J. (2013) 'Makerspaces: the future of innovation', *Profit Guide*. Available at: <http://www.profitguide.com/industry-focus/manufacturing/the-future-of-innovation-57873/2>

Make. (n.d.). Website. Available at: <http://makezine.com>.

Maker Faire. (2014) *Attendee study: Maker Faire Bay Area 2014*. Available at: http://makermedia.com/wp-content/uploads/2013/01/MFBA-2014-research-deck_FINAL.pdf

Maker Faire Africa. (n.d.). Website. Available at: <http://makerfaireafrica.com>

maxigas & Troxler (2014) 'Digitally-operated atoms vs. bits of rhetoric: a mashup', *Journal of Peer Production*, 5. Available at: <http://peerproduction.net/issues/issue-5-shared-machine-shops/editorial-section/digitally-operated-atoms-vs-bits-of-rhetoric/>

Morozov, E. (2014) 'Pick up a spot welder and join the revolution', *New Yorker*. Available at: <https://www.newyorker.com/magazine/2014/01/13/making-it-2?currentPage=all>

Murray, R.P. & Hand, C (2015) 'Making culture: locating the digital humanities in India', *Visible Language* 49(3), pp. 140-155. Available at: <http://visiblelanguagejournal.com/issue/172>

Ndemo, B. & Weiss, T. (eds) (2017) *Digital Kenya: an entrepreneurial revolution in the making*. London: Palgrave. Available at: <https://www.palgrave.com/us/book/9781137578808>

Open African Innovation Research (Open AIR) (n.d.). 'Research'. Available at: <http://www.openair.org.za/research>

Smith, A., Fressoli, M., Abrol, D., Arond, E. & Ely, A. (2016) *Grassroots innovation movements*. London: Taylor & Francis.

South African Maker Collective (2017) 'Maker Collective feedback' [email], 29 March.

South African Maker Collective (2018a) 'South African Maker Collective Constitution' [draft], 3 February.

South African Maker Collective (2018b) 'SA makers collective formalization: draft constitution doc & maker weekend planning' [email], 5 February.

Von Hippel, E. (2005) *Democratizing innovation*. Cambridge, MA: MIT Press.

Von Hippel, E. (2016) *Free innovation*. Cambridge, MA: MIT Press.

Waldman-Brown, A., Obeng, G.Y. & Adu-Gyamfi, Y. (2013) 'Innovation and stagnation among Ghana's technical artisans', paper presented at the 22nd Conference for the International Association of Management of Technology, Porto Alegre, Brazil.

Waldman-Brown, A., Obeng G.Y., Adu-Gyamfi, Y., Langevin, S. & Adam, A. (2014) 'Fabbing for Africa's informal sector'.

Wang, D., Dunn, N. & Coulton, P. (2015) 'Grassroots maker spaces: a recipe for innovation', paper presented at the 11th European Academy of Design Conference, Paris Descartes

University.

Yoder, B. (2015) 'Let's talk about the maker movement in Africa', *Parisoma*. Available at: <http://www.parisoma.com/blog/posts/the-maker-movement-in-africa-must-be-built-by-africans>

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MAKING IN BRAZIL: CAN WE MAKE IT WORK FOR SOCIAL INCLUSION?

Rafael Dias, Adrian Smith

Brazil is a country where many initiatives connected to making have recently emerged. It is also a country in which poverty and social exclusion are still major problems. Seeking to address these problems, experiments in “social technologies” – artefacts, processes and methods oriented towards promoting social inclusion – have developed in the country. There are also interesting examples of “gambiarras”, creative technical solutions produced under scarcity. We review points of connection between these different cultures, making use of the idea of technology scripts to consider how each challenges dominant norms for technology in society, and provides alternative scripts for more inclusive development. The paper then explores the actual and potential role of makerspaces in the city of São Paulo, arguably Brazil’s making capital and the first municipality in the country to create an effective public policy to foster socially inclusive making initiatives. By doing so, we seek a better understanding of how makerspaces may contribute to more socially inclusive relationships with technology.

Keywords: making, inclusion, exclusion, development, Brazil

By Rafael Dias & Adrian Smith

INTRODUCTION

Over the last few years, a lively debate around making and makers has arisen (Anderson, 2012; Hielscher and Smith, 2014; Claude, 2017). The notion that any person or group has the potential to create and modify material objects using increasingly accessible digital tools is attracting large numbers of people to have a go themselves. The phenomenon is also intriguing significant numbers of observers and academics, who try to explain developments, as well as interesting a variety of cultural, educational and innovation institutions and agencies, such as libraries, schools, museums, and local authorities, who wish to engage and support this activity for their institutional purposes.

Many aspects define making and differentiate groups within the broader maker movements. But perhaps the fundamental characteristic of making

that we wish to explore here is the notion that it subverts the boundary that traditionally separates producers and users; whether collapsing these two identities into a new maker identity, an idea explored by Gauntlett (2011), or inserting ambiguity and complicating assumptions about relations between them.

Granted, the generic idea of crafting any given artefact is not something new, nor altogether rare. Countless cultures, particularly in non-mercantile societies, are familiar with this practice and continue to practice it. Making, however, has a special significance in Late Modern societies, due to the way in which industrialized consumer goods are generally produced, distributed and commercialized through processes that are increasingly distant, complex and unfathomable for individual consumers.

Thus, a fairly complex artefact, such a personal computer or a mobile phone comes to be through the coordinated efforts of different firms that supply their different components and parts, and

afterwards travels through intricate distribution and marketing channels until it reaches the hands of a consumer, who buys it as a branded consumer good and puts it to use. All this is part of the dynamics of capitalist economies, through which a kaleidoscope of sociotechnical processes is engaged and roles are performed, including the construction of the producer/user boundary. This notion is present in the critique of “Conventional Technology” inspired by the Appropriate Technology movement and its theoretical and political offsprings, such as in the elements around the concept of Social Technology (see Dagnino, 2014), on which we will later elaborate further.

Making in such circumstances is interesting because it subverts many pre-ordained roles. Such subversion can often be playful and personal; but it can also be understood as a political act, even if it is not intended to be one, because it has the potential of challenging, and perhaps even changing, the sociotechnical order from within. Whether it is curiosity, pragmatism, nonconformity or any other impulse that drives makers (and there seems to be quite a number of different motivations), making presents quite a striking attitude towards technology, and whose origins include a hacker ethic that is sometimes overlooked, but that should not be ignored. Making at its most intriguing involves an ethic that drives people to “open up” technology, to hack it, to create new uses and new forms.

Whilst many have explored the implications of these features in making, they have tended to do so from a North American or European position, and thus consciously or unconsciously tend to reproduce certain situated assumptions about manufacture, design, technology and society. This outlook often overlooks how these features are experienced and perceived from different positions around the globe, and how they fit differently into global manufacturing and consumption systems, or sit apart from them, in places situated differently in the history and geography of production and consumption systems. Given the predominant

vantage point, we attempt through the following pages to contribute to the discussion by offering a view from a somewhat different place and angle, by considering how making plays out alongside pressing issues of social inequality in Brazil.

The paper is divided into four sections, apart from this Introduction. In the next section, we delineate some of the fundamental aspects of how artefacts are normally produced in Late Modern Societies. We look into the main ideas and motivations of maker movements which, we argue, are capable of disrupting and generating changes in the apparently unshakable order of production and consumption. In order to make our argument, we use the concept of ‘technological scripts’ developed by Madeline Akrich (1992), which permits an exploration of what the designers, users, and hackers of technologies intend and negotiate in their development and application. Section three is dedicated to the discussion of strategies for supporting and developing maker initiatives, which if negotiated appropriately we believe could have a positive effect on sustainability, inclusion and democracy. This is done by considering and tracing connections between making, inclusive innovation and the practice of “gambiarra”, a technical subversion of sorts rooted in a culture of improvisation indigenous to Brazil. Based on these ideas, we move to an empirical exploration of these possibilities in inclusive making, and their limits in section 4. We discuss the case of the Fab Lab Livre Cidade Tiradentes, which was established to promote inclusive making in Brazil. In this paper we use this experience as an illustration of sorts. We are confident a deeper analysis of the case would provide very interesting new elements, but our goal here is different. We merely wish to reflect on some broader theoretical questions by connecting them with our initial empirical observations in a way informative for future analyses. Lastly, in section 5, we present some closing remarks based on the material covered in the paper and advocate for a stronger research agenda for inclusive making.

SOME THOUGHTS ON THE PLACE OF MAKING IN LATE MODERN SOCIETIES

In *Technics and Civilisation*, originally published in 1934, Lewis Mumford anticipated that:

“As our basic production becomes more impersonal and routinized, our subsidiary production may well become more personal, more experimental, and more individualized. This could not happen under the older regime of handicraft ... for the acquisition of skill necessary for efficient production on a handicraft basis was a tedious process, and the slow tempo of handicraft in the essential occupations did not give a sufficient margin of time for achievement along other lines ... With electric power a machine shop may have all the essential devices and machine tools – apart from specialized automatic machines – that only a large plant could have afforded a century ago: so the worker can regain, even within the machine occupations, most of the pleasure that the machine itself, by its increasing automatism, has been taking away from him. Such workshops connected with schools should be part of the public equipment of every community” (Mumford, 2010 [1934], p. 415).

For most of the 20th Century this vision failed to materialize. Though there are experiences that converge to what Mumford predicted, it is safe to say that, to a great number of people in developing consumer societies, the everyday, creative act of producing something with electric-powered devices was far off. Instead, we have grown so accustomed to conceding agency to the unshakable presence of increasingly complex technologies in our lives that we tend to overlook the way technical progress generates and requires scripts in Late Modern societies that reinforce an apparent move from the social to the technological milieu. This, as Ellul (1990) claimed, would be one of the core moves in the emergence of “technological societies”.

In a way, technical progress clouds our perceptions of how technology effectively changes the way we live. We have grown accustomed to a sense of technological determinism, and to follow the lead of artefacts. In so doing, people can overlook the myriad social choices taken in the design, development, and use of those technologies – the scripts that are followed – and thereby ignoring the fact that technologies are permeated by politics, as Winner (1986) reminds us. As consumers of goods we often tacitly accept the decisions and cues made by creators, designers, engineers and developers, to which we will broadly refer to as “producers”. It is their decisions (evidently, conditioned by a wide array of social and technical factors) that are eventually materialized through design or expressed in documents such as licenses, warranties or terms and conditions.

Even if it is within the capabilities of users to deviate from the intended forms of use of certain goods – computers, cell phones, domestic appliances, automobiles and so on – such deviations are usually met with some kind of sanction or risk to the user, warranty voidance being one of the most common. Hardware is still mostly “closed”, in the sense that it does not grant users absolute freedom to explore boundaries and stray at their pleasure. Artefacts are produced within established technological frames (Bijker, 1986), in which theories and ideas, tacit knowledge, engineering practices, technical procedures, user routines, and so forth are anticipated and folded into production. This set of conditions generate the structures under which problems are identified as technological and solutions are developed and implemented. Conceiving and designing technology involves charting a desired course to be taken by users. Of course, once out in the wider world, such technological intentions do not always go to plan, but these originating designs are nevertheless the intent, and producers are in the privileged position of setting the initial coordinates. Embedded in technologies are the ideas and expectations of those that produce them, as in a script for the rest of us to

interpret and perform.

Akrich (1992, p. 208) points out that those designing and producing technologies generate and follow scripts about their purposes and uses. Producer scripts “define actors with specific tastes, competences, motives, aspirations, political prejudices, and the rest, and they assume that morality, technology, science, and economy will evolve in particular ways. A large part of the work of innovators is that of “*inscribing*” this vision of (or prediction about) the world in the technical content of the new object”. Through this process, technology communicates an intention, be it evident or not. This is what Akrich calls a technological “script”.

Scripts generate a particular order, envisioned by producers, that is to be followed by users. There are, however, routes of flight from the directions of technology producers, and that allow these devices to be ‘de-scripted’ by more subversive users, or more simply because for some reason actual users do not stick to the intended script (Akrich, 1992). The mechanisms and functionalities envisioned by producers may, therefore, be deconstructed and reconfigured by users.

With the above in mind, we could consider making to be an extreme example of de-scripting. Computer-numerically controlled machine tools and rapid-prototyping technologies intended originally for the purposes of automation in industrial settings, and which promised to deskill and displace manufacturing workers, are being appropriated by makers for more creative, human-centred application in other settings, and for hence for wide varieties of purposes. The new script involves hacking and defying the norms of the incumbent technological order, seeking technologically-facilitated autonomy rather than subordination. What we might call hacker scripts. That said, makers are systematically facing the risk of falling back into line with the adapted scripts of producers, who now see maker designs, prototypes, and enthusiasm as open innovation amenable to appropriation by incumbent global manufacturing circuits (Smith,

2017). Nevertheless, even these more conformist scripts, susceptible to capture, are nevertheless renegotiating earlier scripts.

What Akrich describes in her concept of scripts is ultimately a process through which technology is defined by a negotiation between different meanings and uses, but not necessarily through changes in design. Most common forms of de-scripting involve generating new ways to use any given technology different to the ones defined by its producers. E-mail inboxes, for instance, gradually shifted from being just an interface through which online messages were read and sent to becoming a virtual storage device, where users keep a secure and organized virtual data archive. But users did not have to promote any changes in their e-mail accounts to do so. They simply started to use this particular technology in a new way: categorising and storing messages and discussion groups. Similar things have happened elsewhere, such as with the telephone, SMS messaging, drum-machines, bicycles and so on through a long list of many devices.

Making, on the other hand, implies a deliberate attempt to tamper with design, either by executing incremental changes in hardware, revitalizing broken or obsolete objects, customizing mass-produced goods or crafting new artefacts altogether. As Gauntlett (2013: 233) claims, “the idea of making and sharing is already a political one”. It is the result of a new attitude towards technology, even if it is sometimes an unconscious political act. And it is significant because it redistributes power by unsettling the sphere in which things are produced and opening up to new interventions. Makerspaces and hackerspaces create a more or less inviting environment for this to occur and for users to become involved.

Of course, some grassroots movements have been trying to “open” hardware for decades (Pearce, 2012; Smith, 2014; Hielscher and Smith, 2014), much as others have been doing the same with software (Deek and McHugh, 2008). Makers are

among these groups who have been trying to appropriate, redirect and repurpose technologies. Part of the maker culture bears a revolutionary character because it defies the production-consumption logic described (and scripted) above. Making might be a political act if it is based on a conscious choice of not following the predetermined technical script, and awareness of the implications of becoming involved in other scripts.

There certainly are different motivations and purposes that lead people to create, craft, fix or improve artefacts. It might be the outcome of a pragmatic attitude towards technology, as when a specific, punctual problem is met with a fitting technological answer seeking to solve or alleviate it, or when a broken gadget is fixed by the user. It might be a result of curiosity, as in a pursuit of personal satisfaction through creation and craft (e.g. as it is common among hobbyists). It might be an instrument for entrepreneurs to generate innovative products that may propel start-ups. Or it might be a downright subversive deed, a deliberate act of technological non-conformity, such as extending and repurposing the life of products and challenging consumerism. Or... it might be a combination of all of the above.

Evidence collected by Smith (2017), shows that there are many differences among makerspaces and groups often identified with making. Some do act in ways we might call “technological non-conformists” and as emphasised in our focus here on subversive describing. A great number of makers, though, seem happy to embrace at least part of the global manufacture script, thus joining in “a wave propelled by a celebration of entrepreneurship and individual initiative, whilst often inattentive to any associated downsides, such as new forms of exploitation and precariousness” (Smith, 2017, p. 9).

Important here is the social aspect of individuals and groups organized in workshops or “makerspaces” such as HackLabs, FabLabs and tech shops. Through systematic sharing and networking, these myriad activities are gradually evolving into communities

that, as Hielscher and Smith (2014) stated, might be considered part of a “peer production movement” based on social interactions rather than on the sole efforts of DIY hobbyists.

Gauntlett (2011) emphasises making is about connecting. It is about bringing people together to solve problems, to create and craft. And it provides and strengthens connections not only between individuals and groups, but also between people and technology. The maker movement is evidence that other ways to interact with technology are a real possibility. It shows that we can transcend the strictly utilitarian, passive production-consumption connection we have built with technology throughout Modernity, and to ask questions about establishing deeper, and more active link with the artefacts that help constitute our worlds.

But where is the maker movement now, exactly? Anderson (2012: 17) claims,

“Here’s the history of two decades of innovation in two sentences: The past ten years have been about discovering new ways to create, invent, and work together on the Web. The next ten years will be about applying those lessons to the real world”.

There is an alluring straightforwardness to this script. Maker movements have, indeed, managed to build social and cognitive capital that enables the growth of new material practices. A very diverse set of early initiatives is now taking an increasingly transnational shape, as collectives of makers interact through newly opened channels such as workshops, fairs, blogs and websites. Although these links are still mostly present in the Northern Hemisphere, makers based in developing countries are also joining these networks, while international development agencies have shown an appetite for helping make the connections.

These trends have led authors such as Anderson (2012) and Troxler (2013) to speak of a new industrial revolution in its own right, with making at

its core. By exploring the potential of rather complex technologies made progressively more accessible due to their falling costs, as is the case of 3D printers and scanners, computer numerical control (CNC) machines and laser cutters, makers have made a very clear point regarding the latent innovative potential that lies outside of the borders of conventional firms.

If this attitude towards technology indeed heralds a revolution it is still early to tell. It is not uncommon for predicted technological revolutions to be frustrated. That, however, does not mean we are not facing valuable “scenarios of experimentation” through which potentials may be explored and some realized (Fressoli and Smith, 2015).

Therefore, even if the transformative potential acclaimed by enthusiasts of making is elusive, it is nevertheless possible to identify some elements within the maker movement that open up to renewed scrutiny received scripts about producers and users and about technology-society relations. First of all, there are new tools (and new uses to “old” tools) that enable people to create, prototype and craft new products; second, there is an impulse among makers, a tacit norm of sorts, that leads them more towards sharing and collaboration than to economic competition; lastly, there is a wide set of common archive sharing formats that allow makers to further adapt and develop new scripts. The latter also brings with it the possibility to link with commercial producers, enabling prototypes to be produced at scale, and thus connecting entrepreneurs to the more established scripts of producers. Taken together, these elements constitute a new milieu for technology scripts. Amidst this new, old and hybrid scripts being generated, one can perceive promising mechanisms for promoting social inclusion and which may assist certain countries in seeking alternative strategies for development.

INCLUSIVE INNOVATION, SOCIAL TECHNOLOGY AND GAMBIARRA:

POTENTIAL LINKS TO MAKING

From the perspective of a developing Latin American country, a change in scripts seems long overdue. In fact, much of the regional and Brazilian literature on science and technology policy produced during the last four decades point to incompatibilities between imported high-technology scripts and the local social, economic and cultural contexts for large parts of the population (Medina et al, 2014). Despite these observations, policy-makers in Brazil and the region have been tenacious in following what we could call a “catch-up” script: trying to emulate policies and develop knowledge and technology from Northern economies so that the country can follow its richer northern counterparts more productively and competitively. Implementing this script has sometimes created enclaves of advanced development, but has largely failed in delivering the associated promises of widespread social development.

Social exclusions tend to be glossed over by these policies, and seen as a separate distributional issue, rather than requiring action inherent to the technological scripts themselves. More critical voices have long argued that alternative technological scripts, that are more inclusive by design: authors such as Amilcar Herrera, Oscar Varsavsky, Jorge Sábato and José Leite Lopes proposed such a strategy for the region a long time ago (Thomas and Dagnino, 2005).

More recently, over the last fifteen years or so, a number of experiences in “social technology” in Brazil have been trying to develop a more inclusive script, based in cooperation, solidarity and inclusion, rather than on the mainstream policies that currently shape technological development (Dagnino, 2014).

Social technology is the Brazilian counterpart to “inclusive innovation”, “grassroots innovation”, “pro-poor innovation” and other similar expressions presently in use. Social technology refers to approaches that, while recognizing the limits of

mainstream technology strategies for development, propose alternatives centred around the need for *promoting inclusion through technology*, and even more democratic approaches to technology development in some instances (Dagnino, 2014). We believe there is a promising relationship to be fostered between these social technology approaches and maker initiatives.

As pointed out in Smith (2017), “the design, development and control of technologies can be key in determining patterns of social development” (p. 3). That being true, some fundamental questions regarding strategies to make makerspaces more open and concerned with social technology issues such as inclusion and democracy-building should become part of the broader discussion.

In these terms, if making could be and should be more inclusive, there seems to be some possible interesting connections to other scripts that could be explored in order to promote maker inclusiveness. Through the next few pages we briefly explore two of these potential links with scripts concerning inclusive innovation and the practice of *gambiarra*.

Concerns regarding the relationship between innovation and inclusion on its many levels are not particularly novel, but have attracted renewed interest over the last years. Several authors have recently stressed the importance of fostering initiatives that have fallen under a wide variety of labels, such as inclusive innovation, pro-poor innovation, base-of-the pyramid innovation, below-the-radar innovation and grassroots innovation (Heeks, Foster and Nugroho, 2014).

Chataway, Hanlin and Kaplinsky (2013) argue that, apart from China, there has been a significant uncoupling between economic growth and social and economic development, partly due to the conventional trajectory of innovation, which draws from “increasingly capital intensive, large scale and environmentally damaging technologies to produce goods and services for rich consumers” (p. 23), and

what we called the “catch-up script”. This global trend, they believe, may be countered by an alignment of other factors:

“A key development has been the growth of technological capabilities in the south, and allied to the rapid growth of low- and middle-income consumer markets in these economies, we have begun to witness a major transition in the market orientation of profit-seeking investment and innovation. An increasing number of private sector actors are targeting inclusive innovation as sources of sales and profit. Allied to this, large scale Development Funds and governments and aid agencies have also begun to direct resources to promote inclusive innovation and sales” (Chataway, Hanlin and Kaplinsky, 2013, p. 23).

On a similar note, Cozzens and Pereira (2008), recognizing the limits of mainstream science, technology and innovation (STI) policies in generating inclusion through a fairer distribution of income, and they too have advocated for a new policy model to go beyond what they have dubbed the “Knowledge Economy Policy Paradigm”, and be fundamentally oriented towards reducing exclusion and inequality through science and technology under a “Social Cohesion Policy Paradigm”. While observing some promise on the shaping of “integrated, multi-objective frameworks for STI policy”, Cozzens and Pereira stress that “the full development of that framework and agenda depends, however, on sustained, long-term work to develop new performance criteria, new objectives and different accountabilities” (p. 25).

We agree with this diagnosis. While there is promise and potential in the attention these proposals have received amongst some development agencies (OECD, 2015; World Bank, 2012, 2014), a successful shift of STI policies and practices towards inclusive innovation will depend on the alignment of the discourses, interests and agendas of diverse actors. But, where we might differ, is in our scepticism

about relying upon policy elites to make this shift themselves or through exhortation in academic debate and elsewhere, not least because many of those elites benefit from the prevailing paradigm.

In this sense (and again trying to address the question on whether making can be more inclusive), we believe that there are many benefits to be reaped through a stronger interaction between promising scripts through concrete activities that build changes from below. As we have pointed out before, there seems to be a latent potential for making to become a widespread tool for promoting inclusion on its many levels. In challenging dominant technology scripts, and building alternative scripts, maker movements might help – when aligned with more powerful social movements – to circumvent policy-makers, and work more directly with scientists, engineers and entrepreneurs to develop alternatives that eventually pressure policy-makers to catch-up with the inclusive script. Rather than opening up the innovation agendas, policies and processes in order to include poor and marginalised groups *as a result of elite strategies*, a maker-enabled approach would include groups *as part of* the development of new policies and strategies.

So, how could making begin to play such a role, and how is it doing so already? What features, good and bad, of existing practices should be taken into account in order to foster the creation of effective inclusion-oriented maker spaces?

The Brazilian experience with social technology – “tecnologia social” in Portuguese (see Dagnino 2014) – presents some relevant lessons for promoting social inclusion through technological change. Amongst social technology’s lessons of potential use to more inclusive scripts for maker practices, is the notion that when it comes to social technology the processes are often more important than the artefacts they generate. When building a rain-water cistern for promoting access to clean water, or when designing an urban farm to produce food for a poor neighbourhood, it is crucial to involve users in all stages and build transferable capabilities

and solidarity amongst participants. This helps reinforce social bonds, to develop a stronger sense of community and to empower individuals and groups. It positions any technology production and use as an inherently social, and even political, activity under the control of the community of users, rather than a product gifted from outside. It seems there is a valuable lesson for makers here, since the hype around the tools and equipment that inhabit makerspaces, much as the objects and gadgets that emerge from them, tends to overshadow the daily practices and routines that may act as significant vectors of inclusion (as well as distracting from frank reflection on practices that currently exclude).

Another element that, as we have previously stated, may contribute to shaping inclusive making strategy particular to Brazilian is the culture of *gambiarra*, celebrated in the country as a testament to the creativity and innovativeness of people who lack the means to access or buy ready-made products and solutions.

Brazilians celebrate *gambiarra* as an intangible heritage. It is an ethos that involves temporary, often low cost, sometimes illegal solutions to daily problems, and which involves mixing and mashing together whatever things can be found to hand in order to make a working artefact. From hair clips or nails to fix the straps onto flip-flops, to adaptations to old VCR players that enable them to (illegally) receive paid TV signals, *gambiarras* are widespread. Bouffleur (2013) presents a comprehensive discussion on the topic, identifying some notable and curious examples of common Brazilian *gambiarras*, from simple adaptations to significantly complex re-engineering.

Beyond the quaint and folksy presentation of *gambiarra*, we believe there is strong creative potential that could be explored in order to promote more inclusive making, and hence explore alternative scripts for technology in economic and social development. Bouffleur (2007:7) states that *gambiarra* is “basically the act of improvising material solutions with utilitarian purposes from

industrialized artifacts” (authors’ translation). According to the author, it is, simultaneously, a form of technical improvisation, of utilitarian readjustment and of subversion of conventional industrial design, somewhat like Ernesto Oroza’s studies on “technological disobedience” explored in the film “Cuba’s DIY Inventions from 30 Years of Isolation”.

In this sense, it is a form of technological transgression through which users expand the intended functionalities of industrial artefacts. Thus, *gambiarra* is also a form of challenging the proposed technological scripts whilst shaping alternative scripts through social and technological improvisations that establish solutions to given (everyday) problems. Moreover, the scripting involved in *gambiarra* makes use of informal knowledge and everyday tools.

Understood as a way of not just dealing with technology, but as a method for developing new technology, *gambiarra* has the potential to boost Brazilian creative capabilities and to strengthen maker culture in the country, whilst translating the latter to local specificities. The serious, systematic analysis of *gambiarra*s could offer insights on below-the-radar innovations in the country, and how digital fabrication can play an augmentative role.

Exploring its potential interface with maker culture, Fonseca (2015) points out that *gambiarra*, a sort of “everyday innovation”,

“refers to all kinds of improvised solutions to concrete problems that appear when one doesn’t have access to the proper tools, materials, parts or specific knowledge to perform a given task. It is all about repairing or re-purposing objects that seemed to be of little use but end up acquiring new value out of tacit, applied creativity” (p. 57).

Fonseca criticizes makers’ current obsession with emulating industrial methods and practices, which he believes reveals a difficulty in breaking away

from conventional market and production assumptions and embracing the potential of making as a script for transgression and resistance. Through a *gambiarra*-inspired approach to artefacts, Fonseca sees the possibility for an alternative script to be written and performed by the maker movement, one that would be driven by everyday repair efforts and more technology for longevity and sustainability rather than by the endless production of novelty that tends to be celebrated currently. A script centred on users’ creativity and respect for materials, and not so much on mastery of tools per se.

If “making is connecting”, as Gauntlett (2011) puts it, then *gambiarra* may be a driving value to be incorporated into maker culture and scripts. After all, it is about accepting different bodies of knowledge and practice and reconnecting people to everyday doing and crafting.

SÃO PAULO’S RECENT EXPERIENCE IN INCLUSIVE MAKING

In parallel to what is happening in different parts of the world, Brazil has also experienced a surge of experiences related to socially inclusive technology strategies. Over the last fifteen years, *social technology* – the local term used to address products, processes and methods aiming towards promoting social inclusion – has become an increasingly important element of the science, technology and innovation policy in the country, despite some recent setbacks (Fressoli and Dias, 2014). The notion that knowledge and technology should be understood as constitutive core aspects of social inclusion strategies has since become a generally accepted part of the country’s inclusion policy framework, which influenced the city of São Paulo’s experience we describe over the next few pages.

With a population of over 12 million people, São Paulo is by far the largest city in Brazil and one of the largest in the world. It is also a place of clear contrasts, where century-old buildings sit uneasily

alongside skyscrapers built with metal and glass, where traditional family-owned businesses stubbornly subsist amidst giant commercial corporations, and where extreme poverty coexists with imposing wealth and luxury.

In this sense, the city of São Paulo is an emblematic example of the historic Brazilian socioeconomic condition. According to the 2016 IMF estimates, Brazil had a GDP of US\$ 1.534 trillion and a *per capita* GDP of US\$ 7,447. The city of São Paulo was responsible for a considerable share of this product, with an estimate GDP of around US\$ 180 billion (about 11,7% of the total Gross Domestic Product), according to the 2013 Brazilian Institute of Geography and Statistics (IBGE) Census, and a *per capita* GDP of roughly US\$ 15,000. São Paulo is a rich, productive city, and a very unequal one: current data on the UN's Human Development Atlas show that the Gini coefficient for the city is 0,62, while Brazil's is 0.518, meaning that inequality in the city is above the country's average.

São Paulo may also be considered a place where values such as entrepreneurship and innovation tend to be appreciated. It is certainly a national reference in terms of creative industry and it is becoming a modest hub for Brazilian makers: over the course of the last few years, several maker spaces and digital fabrication labs have emerged in the city. One set of makerspaces that stands out due to their nature is twelve of the city's fab labs are public, meaning that they not only are free and open to the general public, but also funded by the local administration and jointly managed with ITS Brasil, a non-governmental organization committed to fostering science and technology for social inclusion in Brazil, with significant former experience in social technology initiatives.

This network emerged as the organizational core of the Fab Lab Livre SP Programme, launched in 2015 by mayor Fernando Haddad as an initiative under the city's Secretary of Services, which set the general outline of the project. The twelve fab labs are spread throughout the city of São Paulo, as seen

in the figure below:

The Fab Lab Livre SP Network

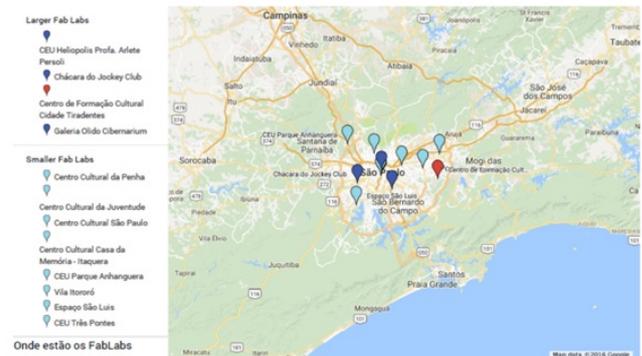


Figure 1. Source: authors' elaboration based on data from the Fab Lab Livre SP Programme.

The Programme involves a team of about thirty people. It had an original budget of US\$ 2 million and was initially set to span a period of two years, with the possibility to extend its duration. 62.5% of the budget was destined to cover costs throughout these two years, while 37.5% were meant to fund the acquisition of tools, hardware and software. A significant - if mainly symbolic - aspect of the Programme is the contractual demand that all software used at the fab labs must be free software.

Though they share a common public nature, these fab labs also have some relevant differences between them. The majority of them are mostly visited by artists, designers, architects, engineers and college students and tend to be seen predominantly as spaces for creative expression. Others are mainly concerned with promoting education and are often visited by curious, enthusiastic children and teenagers.

As a whole, this network of workshops presents an opportunity for the broader script to be re-written, since it is offering users a chance to meddle into the technical establishment. It also offers possible inspiration for developing countries to write scripts of their own, based on their own challenges and goals, rather than by following the technological paths dictated by the so-called developed countries.

This alone would seem like a relevant strategy to be pursued, making the São Paulo experience worthy of note.

There is one of the twelve fab labs, however, that stands out from the rest: the one situated at Cidade Tiradentes, on which we will focus here, not as a case study, but as an illustrative experience that may provide us with new elements to reflect on the possibilities of de-scripting through making. It is situated on São Paulo's very rim, on its eastern part. Cidade Tiradentes is one of the poorest neighbourhoods in the city, presenting indicators that clearly denote this status. Evidence presented by the Map of Inequality, a report published by the Nossa São Paulo Network (www.nossasaopaulo.org.br) in 2016, shows that Cidade Tiradentes is one of the poorest regions in the city. Fortunately, the neighbourhood's overall situation seems to have slightly improved over the last few years, according to recent data derived from the Network, partially due to the implementation of some basic public services in the region, such as schools, day-care centres and internet access points - the latter as "telecentros", free neighbourhood lan houses.

The Fab Lab Livre Cidade Tiradentes stands out from its counterparts because it is particularly - and explicitly - concerned with social inclusion. Additionally, it was the first of the twelve fab labs to be opened, in December 2015. It operates from a large public complex, Centro de Formação Cultural Cidade Tiradentes, which hosts an open library and theatre, a "telecentro", as well as several workshops and courses open to the general public.

From the moment one enters the fab lab at Cidade Tiradentes, one of the most striking impressions it gives is in the contrast between the haphazard surrounding the building and the organized, clean disposition of the equipment and furniture inside the lab, as symbolically illustrated by the figure below.



Figure 2. Source: authors' archive.

While most of the other labs in the São Paulo network are visited by its fair share of artists, architects, graduate students and geeks (much like other labs around the world), a large number of those who regularly visit Fab Lab Livre Cidade Tiradentes are children and teenagers (often on school field trips) and unemployed artisans, mostly masons and carpenters who live nearby.

These groups' motivations certainly differ, however: while the younger visitors are driven by curiosity and a fair deal of fascination towards the seemingly futuristic equipment at the lab, the artisans seek the means to craft and produce without charge for the use of the machinery. The lab receives roughly 1,000 visitors each month, including walk-ins or people attending some of the courses offered periodically (on themes such as electronics, digital fabrication, crafting, Inkscape, robotics and arduino).

Most of the activities developed in the lab have a strong connection with educational practices. Some of the lab's team members commented on how school visits had a visible effect on children's curiosity regarding fabrication, tools and equipment. But they also claimed that being in contact with the lab helped the overall improvement of school performance. As an example, they recalled that some children (around ten years of age) did not

know how to properly use a ruler, and would often ignore the grading under the 1cm mark. They would also be lacking basic notions of space and size and would have difficulty in estimating the dimensions of furniture, for example. When challenged by the lab's team members to 3D print some clothes hangers, they would initially struggle due to these issues. They were then invited and assisted to take measurements and to register the numbers they found, so as to produce proper, functional hangers. This brief example is instructive, since it shows how the access to making can aid in developing knowledge and competences sought, but not always gained, in formal schooling.

The example above also suggests the outline of a strategy for rescripting making for social inclusion. Just as schools and makerspaces might converge towards a common, relevant goal, inclusive makerspaces should be shaped as catalysts of further interactions among other actors. In other words, the educational use of makerspaces provides relatively limited social inclusion if participants are educating along the lines of predominant technology scripts that reproduce the exclusions experienced under catch-up technology policy. Education and training should include more critical and radical experiences and scripts for social technology development. Activity needs to consolidate rather than contradict the identity of the Cidade Tiradentes Fab Lab as socially inclusive, and there seems to be some connections being formed already. The nearby community theatre, in the same building, has used scenographic objects produced at the Lab's benches, a small yet significant accomplishment. In the future, objects and parts created at the Lab could also become visible throughout nearby schools and parks, on workers' cooperatives, in scrap collectors' carts, and so on.

For this to happen, it would also be strategic if besides providing access to tools and equipment to, say, unemployed artisans, the Cidade Tiradentes Fab Lab could map workers' skills and act towards creating links of productive cooperation between them. Gambiarra culture demonstrates the informal

skills and creativity in communities. Connecting these skills with the resources and possibilities in Fab Labs is an important means to conveying value, status and commitment to such skills. Inclusion, after all, is not only about providing access, but shaping sustainable social and productive relations. It is something that should be on the horizon for this emerging makerspace, and for similar ones that are eventually created.

Besides putting people in touch with new, promising technology, the lab seems to play an important role as a space for people to come together and exercise their creative potential. In poor neighbourhoods in brutally unequal countries this is particularly meaningful, since it may help to fill certain gaps left by the state's historic absence. Gaps which have often resulted in public spaces that are unwelcoming to people or with limited access to precarious basic services, such as housing, education, sanitation, health and security.

Retrieving the powerful idea Gauntlett (2011) presented us with – the claim that “making is connecting” – we can think of the Cidade Tiradentes lab as a space that provides several desirable connections. It allows people to connect to technology just as it enables people to connect to each other. Additionally, it bridges complex technology and formalized knowledge to other epistemics, such as the creative informality of gambiarra, and thereby creating tensions that may lead to very interesting results (more on this a little further down). But it also connects the problems of a given territory to viable solutions, generated by the communities themselves. This is not a trivial thing. Rather, one of the main challenges to developing countries seems to be finding endogenous, sustainable responses to the social, economic, environmental and political problems they face. Experiences such as the Fab Lab Livre Cidade Tiradentes, in this sense, could also be understood as spaces in which making is connecting to the territory and through which communities and neighbourhoods come together to conceive solutions to address their common problems, as

Ribera (2016) suggested.

In other words, it is about an opportunity to use powerful, sophisticated technology to generate real, sensible change – to take maker tools and equipment, practices and culture and translate it, generating a new script for inclusive making, more adequate to the context of developing countries, but still connected to the global network. The symbolic value behind it is also something that should not be ignored. It is a manifestation of the notion that people are allowed to create their own scripts with the help of new technology. It is a statement of access to technology and production as a right to everyone in the city, poor or rich.

Although there are numerous positive elements which can be drawn from this particular experience, there are also some points we believe must be addressed in order to boost the effectiveness of similar makerspaces, oriented towards promoting social inclusion. As a yet very recent experience, it represents possible outlines for a future that may or may not be fulfilled. In other words, though we identify promise on the Cidade Tiradentes initiative, it is important to note that there are important elements to be addressed in order for this initial experience to become a long-term model.

First, there is the issue of bringing forth the “materiality of inclusion” in inclusive makerspaces. As Kohtala (2016) reminds us, values, ideas and narratives are made concrete in the design of the material elements which are visible in makerspaces. We would expect a maker collective primarily concerned with sustainability to embrace sustainable-oriented design, for example. So, should we not expect an inclusion-oriented makerspace to be itself inclusive? This would likely contribute to creating an ambiance and set of practices that could increase the effectiveness of inclusive makerspaces. The FabLab Livre Cidade Tiradentes, as we have previously noted, contrasts heavily with the reality outside of its walls and windows. It could innovate by materializing inclusion in the layout and redesign of the space, which is to say invite neighbours to do

the re-designing of the space or be involved in the process – and this could, perhaps, generate some positive outcomes and lessons. This is easier said than done, especially when one recalls inclusion is about inclusive processes in developing alternative technology scripts, involvement in opening up and critically reconfiguring technology, and inclusion in any resulting artefacts and services. As such, processes for taking activities out of the FabLab, and into the neighbourhoods, whether through citizen innovation labs in different districts, or in situ making, would demonstrate the intent to open up processes and take them to people.

On our visit to the Fab Lab on Cidade Tiradentes, it was mentioned that the children living nearby would sometimes walk inside the facilities with no shoes on – a reminder of the social and economic reality that encircles the lab’s pristine walls and seemingly magical equipment. Motivated by this image, we stress the need for a reframing of making (or for a change in its script) in developing countries towards more inclusive practices and approaches seeking to address relevant social problems while actively engaging the community and linking to other complementary initiatives. This could be the basic elements for a *barefoot making* script.

Thus, the Cidade Tiradentes experience is an example of a small element towards generating a new, rewritten script. The script being shaped inside that particular Fab Lab is very different from what is found in a great number of makerspaces around the globe (and in the other ones that make up the São Paulo network). It tends to drift away from individualistic, market-oriented notions under the guise of alluring terms such as “entrepreneurship”.

Sadowski and Manson (2014) synthesize this process as follows:

“The maker movement is born out of, and contributes to, the individualistic, market-based society that has become dominant in our time. More specifically, the movement fits well into what, nearly 20 years ago, the media theorists

Richard Barbrook and Andy Cameron called “the Californian Ideology.” According to this view, new technologies promise to create a class of high-tech entrepreneurs thanks to their ability to “empower the individual, enhance personal freedom and radically reduce the power of the nation-state.” All while allowing them to ignore or simply design their own way around the established political, economic and legal system.”

By framing problems using a different, unconventional approach, however, the Cidade Tiradentes Lab challenges the boundaries of making. Symbolically, it might be understood as a political act, a subversive maneuver inside a culture split between resistance and conformism.

Shaping inclusive technology under such a script, evidently, is no easy task. There are limits, in São Paulo and elsewhere, that tend to hinder the capacity of barefoot makers to turn their set of skills into the driving force behind new business models or social technologies capable of empowering communities and shifting their circumstances. After all, there are given political and economic relations that are much harder to be rewritten than other parts of the established script.

CLOSING REMARKS

We cannot help but to think about how wonderful it would be if typical makerspaces in Brazil and elsewhere – predominantly inhabited by white males, as observed by Grenzfurthner and Schneider (2009) and more recently verified by Charter and Keiller (2014) – would become increasingly more plural. And not only for the sake of representation itself, but also because the interaction between different bodies of knowledge and practices often generates rather unique, creative solutions. The Brazilian experiences on gambiarra and social technology certainly make a very strong case for that.

Inclusive making experiences could benefit a lot

from the interaction with other convergent initiatives. In Brazil, for instance, there is a strong network of workers’ cooperatives and Solidarity Economy enterprises (see Lemaître and Helmsing, 2012) with which these makerspaces could interact further. By working closely together with scrap collectors, community house builders, urban farmers and other organized or semi-organized collectives, inclusive makerspaces could help to create a richer environment for inclusive innovations to occur. This should be a goal for experiences like the one in Cidade Tiradentes.

Additionally, there is the issue of converting a promising experience into a model for a sustainable public policy. This is not a simple task and tends to be particularly challenging in countries where policies are often discontinued simply for being strongly associated with the previous governments that created them (something fairly common in Brazil). Overcoming these vicissitudes and providing long-term planning and lasting financial and political support – from a variety of actors – are important conditions for keeping successful developments alive.

Although the mainstream script in maker culture often assumes a rather techno-optimistic protagonist, we feel that there are relevant issues to be addressed, particularly when we think about inclusive making. We have pointed out, based on some broader considerations and on thoughts provoked by São Paulo’s Cidade Tiradentes FabLab Livre, that there is as much potential and possibilities for inclusive makerspaces as there are challenges and limitations. In general terms, it is important to note that inclusive making strategies would benefit greatly from a stronger connection to the territory they are in and the neighbouring communities. This means they should seek to respond to local demands, necessities and problems, and learn the art of community development (Smith and Light, 2017).

In his book *Sagarana*, celebrated Brazilian writer Guimarães Rosa reminds us of an old saying: *sapo*

não pula por boniteza, mas porém por percisão. It roughly translates to “the frog leaps not for the beauty of it, but because it needs to”. Inclusive making should draw from local knowledge and creative potential and be driven by real community or neighbourhood needs, drifting away from the obsession with beautiful gadgets and technologies and with making for its own sake. This notion is reinforced by the arguments presented by Gyawali and Thompson (2016), who evoke a related image of “toad’s eye science” to advocate for the pursuit of designing bottom-up situated responses to social problems, rather than a top-down “eagle’s eye approach”.

Evidence presented by some of the authors we mentioned along the preceding pages, as well as many others, lead us to conceive makerspaces as capable of strengthening bonds between people (and between people and technology) and shaping community identity. Makerspaces will be successful in opening up and writing inclusive technology scripts to the extent that they are successful in building inclusive communities. São Paulo’s Cidade Tiradentes, like many other places globally (such as Belfast, Detroit, Amersfoort, Bogotá, and others), illustrates attempts of developing script-making communities: building the capacity of people to appropriate technologies to autonomous local purposes. In the case of Fab Lab Livre Cidade Tiradentes, not only does it play an important role in spreading maker culture (much as the other labs in the São Paulo network), but it takes it to one of the poorest areas of the city, to people who most likely would otherwise be deprived from even knowing the most basic tools and principles of making. And yet, where considerable making skills already exist, hidden in *gambiarra* and the lack of recognition of these skills. Makerspaces need to learn to listen and connect with these skills, and bring their technology scripting resources into an empowering relation with the skills and aspirations of the communities around them. However, such potential will only be fully realized when the experience feeds back into making and translates it to fit into the local context with its specificities.

In this paper we have tried to construct a dialogue between making, technology politics, and inclusion, all as seen from a particular Brazilian perspective. We wanted to imagine makerspaces providing a rich environment for inclusive making. The lessons provided by the experiences on social technology and the pervasive (yet often shunned) culture of *gambiarra* could help promote this development. These alone are unlikely to be sufficient, since other key factors – such as lasting government policies and stronger links with movements for social and economic justice – are still lacking. The São Paulo experience, however, represents a signal for what could become a promising trajectory for inclusive making. It could inspire similar initiatives elsewhere and provide valuable insight for policy makers and scholars.

REFERENCES

- Akrich, M. (1992) ‘The De-Description of Technical Objects’. In: BIJKER, W. and LAW, J. (Eds.) *Shaping Technology, Building Society: Studies in Sociotechnical Change*. Cambridge, USA: The MIT Press.
- Anderson, C. (2012) *Makers: the New Industrial Revolution*. New York: RH Books.
- Bijker, W. (1987) ‘The Social Construction of Bakelite: Toward a Theory of Innovation’. In: Bijker, W.; Hughes, T. and Pinch, T. (Orgs.) *The Social Construction of Technological Systems*. Cambridge, EUA: The MIT Press, pp. 159-187.
- Bouffleur, R. (2007) *Fundamentos da Gambiarra: a Improvisação Utilitária Contemporânea e seu Contexto Socioeconômico* [The Fundamentals of the Gambiarra: the Utilitarian Contemporary Improvisation and its Social-Economic Context]. PhD Thesis, University of São Paulo.
- Charter, M. and Keiller, S. (2014) *Grassroots Innovation and the Circular Economy: a Global Survey of Repair Cafés and Hackerspaces*. The Centre for Sustainable Design, University for the

Creative Arts.

- Chataway, J.; Hanlin, R. and Kaplinsky, R. (2013) 'Inclusive Innovation: an Architecture for Policy Development'. IKD Working Paper N° 65, March 2013.
- Claude, C. (2017). 'Makery Survey: the New Fablab Jobs'. *Makery*, (April), 1-11.
- Cozzens, S. and Pereira, T. S. (2008) 'The Social Cohesion Policy Paradigm in Science and Technology Policy'. Paper presented in the Prime-Latin America Conference at Mexico City, September 24-26, 2008.
- Dagnino, R. (2014) *Tecnologia Social: Contribuições Conceituais e Metodológicas* [Social Technology: Conceptual and Methodological Contributions]. Florianópolis: Insular/EdUEPB.
- Deek, F. and McHugh, J. (2008) *Open Source: Technology and Policy*. Cambridge: The Cambridge University Press.
- Ellul, J. (1990) *The Technological Bluff*. Grand Rapids: Eerdmans.
- Fonseca, F. (2015) 'Gambiarra: Repair Culture'. *Tvergastein: Interdisciplinary Journal of the Environment*, vol. 6, pp. 54-63.
- Fressoli, M. and Dias, R. B. (2014) 'The Social Technology Network: a Hybrid Experiment in Grassroots Innovation'. STEPS Working Paper 67. Brighton, UK: STEPS Centre.
- Fressoli, M. and Smith, A. (2015) 'Impresión 3D y Fabricación Digital ¿Una Nueva Revolución Tecnológica?' [3D Printing and Digital Fabrication: a New Technological Revolution?]. *Integración & Comercio*, n. 39.
- Gauntlett, D. (2011) *Making is Connecting: the Social Meaning of Creativity, from DIY and Knitting to YouTube and Web 2.0*. Cambridge: Polity Press.
- Gyawali, D. and Thompson, M. (2016) 'Restoring Development Dharma with Toad's Eye Science?' IDS

Bulletin, vol. 47, n. 2A.

- Grenzfurthner, J. and Schneider, F. A. (2009) 'Hacking the Spaces'. Available at: <http://www.monochrom.at/hacking-the-spaces/>.
- Heeks, R.; Foster, C. and Nugroho, Y. (2014) 'New models of inclusive innovation for development'. *Innovation and Development*, vol. 4 (2), pp. 175-185.
- Hielscher, S. and Smith, A. (2014) 'Community-based Digital Fabrication Workshops: a Review of the Research Literature'. SPRU Working Paper Series, SWPS 2014-08.
- Kohtala, C. (2016) *Making Sustainability: How Fab Labs Address Environmental Issues*. Helsinki: Aalto ARTS Books.
- Lemaître, A. and Helmsing, B. (2012) 'Solidarity Economy in Brazil: Movement, Discourse and Practice Analysis through a Polanyian Understanding of the Economy'. *Journal of International Development*, vol. 24, Issue 6, pp.745-762.
- Medina, E.; Marques, I. C. and Holmes, C. (2014) *Beyond imported magic: essays on science, technology and society in Latin America*. Cambridge, Mass.: MIT Press.
- Mumford, L. (2010) [1934] *Technics and Civilization*. Chicago: University of Chicago Press.
- OECD (2015) "Innovation policies for inclusive development: scaling up inclusive innovations," Paris.
- Pearce, J. (2012) 'The case for open source appropriate technology'. *Environment, Development and Sustainability*, Volume 14, Issue 3, pp. 425-431.
- Ribera, R. (2016) 'Sharing, makerspaces and the new industrial city'. Paper presented at the 45 EASST Conference, Barcelona 2016.
- Sadowski, J. and Manson, P. (2014) '3-D print your way to freedom and prosperity: The hidden politics

of the ‘maker’ movement’. Available at
<http://america.aljazeera.com/opinions/2014/5/3d-printing-politics.html>.

Smith, A. (2014) ‘Technology Networks for Socially Useful Production’. *Journal of Peer Production*, issue 5.

Smith, A. (2017) ‘Social Innovation, Democracy and Makerspaces’. SWPS Working Paper, June 2017.

Smith, A. and Light, A. (2017) Cultivating sustainable developments with makerspaces. *Liinc em revista*, 13 (1). pp. 162-174.

Thomas, H. and Dagnino, R. (2005) ‘Efectos de Transducción: una Nueva Crítica a la Transferencia Acrítica de Conceptos y Modelos Institucionales’. [Effects of Transduction: a New Criticism to the Acritical Transference of Concepts and Institutional Models]. *Ciencia, Docencia y Tecnología*, n. 31, pp. 9-46.

Troxler, P. (2013) ‘Making the Third Industrial Revolution – The Struggle for Polycentric Structures and New Peer-Production Commons in the FabLab Community’. In: Walter-Herrmann, J. and Büching, C. (Eds.) *FabLab of Machines, Makers and Inventors*. Bielefeld: Transcript Verlag, pp. 33-46.

Winner, L. (1986) *The Whale and the Reactor: a Search for Limits in an Age of High Technology*. Chicago: The Chicago University Press.

World Bank (2012) “Inclusive green growth: the pathway to a sustainable development” Washington DC. Available at:
<https://openknowledge.worldbank.org/handle/10986/>

6058

World Bank (2014) “Makers for development: showcasing the potential of making” New York. Available at
<https://www.usaid.gov/sites/default/files/documents/15396/Makers4Development.pdf>

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MAKING HARDWARE IN NAIROBI: BETWEEN REVOLUTIONARY PRACTICES AND RESTRICTING IMAGINATIONS

Alev Coban

The first makerspace in Nairobi seems to revolutionize the development of hardware in Kenya by introducing new work possibilities for engineers and by turning stereotypes of the Global South (as mere technology recipient) and the Global North (as the only originator of tech innovation) upside down. Nevertheless, postcolonial power asymmetries persist in the relations between international investors and start-ups/makers. By drawing on ethnographic insights, the paper shows how the tech-deterministic and developmental imaginations of global investors and the branding of technology as developed “for Africa” are restricting Kenyan tech developers to only building technology with social impact. Potential customers in Kenya become homogenized as poor and in need of technological solutions, whereby their daily life context becomes ‘othered’ and exoticized as a coherent and rural ‘Africa’. Therefore, the paper claims that practices of making, following a social-impact logic, constitute a performance of poverty, and that the daily negotiations between the investors’ imaginations and the makers’ technological ideas are performatively enacting norms of what – and what not – to build.

Keywords: Making, Kenya, postcolonial, imaginaries, social impact, performativity

By Alev Coban

INTRODUCTION

Do we have our own inherent culture that informs how we go about building stuff, or are we just dancing to the tune of whoever wants to listen?!

(tech expert and researcher, interview, 2015)

All over the world, sites for technological innovation gain international awareness – be it Shenzhen in China, Cape Town in South Africa or Nairobi in Kenya. Accompanied by this awareness is the renaming and branding of those new(ly discovered)[1] places as emerging Silicon Valleys: Shenzhen as the “Silicon Valley for Hardware”, Cape Town as “Silicon Cape” and Nairobi as “Silicon Savannah”. The more success stories and products

are covered by the media, the more people from ‘long’-established places of tech production, like Silicon Valley or Europe, are visiting places that have not yet been in the spotlight of technological innovation. When Mark Zuckerberg visited Nairobi’s tech scene in August 2016 to learn about technology that uses mobile money, it became clear that Nairobi’s reputation as a place of tech innovation had spread to the top level of global tech gurus.

Since 2007, international awareness has been directed more and more towards Nairobi’s tech scene. The starting points of this awareness, and Nairobi’s reputation as a place for technological development, are said to be rooted in two innovations: Ushahidi and M-Pesa. Ushahidi (Kiswahili for testimony) is an open-source software with which everyone who has access to the Internet can map happenings. For instance, this software was used to follow and comment on the post-election violence in Kenya in 2007/08, in order to make the riots transparent (Manske, 2014, p.14;

Ushahidi, 2017). While Ushahidi was spreading, one of the largest mobile network operators, Safaricom, introduced M-Pesa in Kenya. M-Pesa (M stands for mobile and *pesa* means money in Kiswahili) is an application for mobile phones to transfer money via SMS. It became very successful, because it was the first app to include people without access to a formal bank account (Marchant, 2015, p.8). Those two technological innovations applied in Kenya gained such an international reputation that today, various actors throughout the world are using them: Ushahidi, for example, was used by ‘Document Hate’ during the US election in 2016, and M-Pesa was introduced in Romania by Vodafone in 2014 (Vodafone, 2014). Following this awareness of Nairobi as a place of technological knowledge production, development agencies and private corporations such as Google, IBM and Microsoft have invested heavily in Nairobi’s start-ups and co-working spaces.

A relatively new phenomenon in Nairobi is the emergence of a ‘maker scene’, which focuses on the development of ‘stuff’ and hardware rather than the well-funded software development community. Engine[2], the first makerspace in Nairobi, opened its doors in December 2015 with the financial support of private investors and charity organizations. It was established as a solution to challenges faced by hardware companies, engineers and other people who aim to develop new (hardware) technology in Nairobi. Those challenges include the high taxes on imported resources, such as basic soldering wire, little 3-5mm screws for electric circuits or a huge CNC (Computerized Numerical Control) machine, that often render imported goods too expensive to buy (Mungai, 2015). Thus, many engineers in Kenya lack access to resources and machines to prototype cheaply and quickly. Sending a digital model of a prototype to specific companies in the US, getting it built there and then shipping the finished prototype back to Nairobi is one strategy for prototyping that is cheaper and quicker than in Nairobi. Nevertheless, it is a more time- and money-consuming process for Kenyans than it is for engineers in the US or UK. Not

only are individuals challenged as they attempt to gain access to the resources and machines used for building and prototyping, but, in addition, small Kenyan start-ups often do not get deals with global hardware suppliers. To address those needs, Engine offers its members access to high-quality machines. With those offers, Engine consciously separates itself from the amateurish ‘Do-It-Yourself’ stance of many global makerspaces by particularly looking for professionals who have an idea that can be marketed in Kenya (head of operations at Engine, interview, 2015). Its overall vision is to support the development of technologies “Made in Africa, for Africa” and an overall “fourth industrial revolution” in Kenya (Birkelo, 2017; Gachigi, 2017).

Nevertheless, the ‘revolutionary’ vibe of tech production in Nairobi has its limits when confronted with the challenge of raising funds and investments for tech projects. A research partner of mine, the former Head of iHub[3] Research, problematizes the dependency on the values, imaginations and resulting requirements of funders and investors, and demands that local innovators stop “dancing to the tune of whoever wants to listen”, as the quote at the beginning of this section states. Therefore, this paper argues that tech developers and start-ups in Nairobi have to constantly negotiate between liberating feelings about new work possibilities on the one hand, and on the other, restrictive requirements of international funders and investors who still pursue exoticized imaginations of lives in a generalized ‘Africa’. I claim that those negotiations lead to the reiterative process between performing deficient environments and building technology that has social impact on broad problems like poverty. For this reason, I refer to Butler’s paper on “Performative Agency” (2010), where she states: “It is not only the explicit speech act that exercises performative power. [...] It is not simply that a subject performs a speech act; rather, a set of relations and practices are constantly renewed, and agency traverses human and non-human domains” (Ibid., p.150). With this new socio-material stance in her arguments, Butler distances herself from the “cultural constructivist position” that she argued for

in *Gender Trouble* (1990) (Ibid., 2010, p.153). Based on that socio-material notion of performativity, I call the performative practices around tech development in Nairobi that materialize and stabilize the norms of social impact a *performance of poverty*.

To illustrate these arguments, the paper proceeds as follows: firstly, I describe the ethnographic data collection on which this paper is based. Secondly, I outline why a makerspace in Nairobi is called a revolutionary act: on the one hand, because it faces the challenges of manufacturers and hardware innovators in Kenya, and on the other hand, because it creates international awareness around technological development in order to counter stereotypes of a passive and needy place in the Global South. Thirdly, the paper shows how the slogan “Made in Africa, for Africa”^[4] highlights the paradox of the simultaneous critique and reproduction of (post)colonial stereotypes causing ‘othering’. Fourthly, the paper deals with the postcolonial power asymmetries inherent in receiving money from international funders and investors for technological ideas. The imaginations of those companies and development agencies are described as tech-deterministic, social-impact-driven and charitable, and the strategies of tech people in negotiating those imaginations are shown. Finally, the paper concludes by drawing on Judith Butler’s (2010) theory of performativity to argue that the dominance of social entrepreneurship practices in a postcolonial context implies a reproduction of (post)colonial imaginations and, thus, the performance of poverty.

ETHNOGRAPHIC RESEARCH IN A TECH SCENE

The following paper is based on ethnographic research conducted in Nairobi between 2015 and 2017. During those years, I accomplished three research stays, working in total about six months in Nairobi. By collaborating with several (co-)working places, my research focuses on places and practices of innovating and making hardware in Nairobi. Hereby, the research particularly looks at the daily

lives of those people who still constitute the minority of the innovation scene in East Africa: manufacturers and engineers of hardware and electronics. During the research stays, I had the chance to participate at iHub Research; work as an intern at Engine, the first makerspace in Kenya and my main research partner; and attend numerous tech events, such as hackathons, competitions, panel discussions, etc.

Thus, my empirical data consists of ‘ethnographic research’ insights (Crang and Cook, 2007): I mainly used participant observation to bodily experience the everyday practices of developing hardware at Engine (Carr and Gibson, 2017). Additionally, the research is based on qualitative interviews with actors who were not directly involved in my daily life, such as CEOs of hardware companies, influencers in the tech scene, and political and juridical actors. As an important part of my participatory research and aim to approach some principles of the ‘Charter of Decolonial Research Ethics’, I organized round-table discussions to discuss preliminary research results with the people I worked with. My exploratory research soon immersed me in sensitive topics such as the stressful working conditions of a hardware entrepreneur, race categories and their discriminatory effects, and personal visions and role models of Nairobi’s tech enthusiasts. Using some of those intimate insights in this paper, I decided to anonymize all research participants, even if some did not mind being named in a publication.

Conducting repeated research stays during a time frame of three years allowed me to continuously work with several research participants. Thus, I could observe and participate in various institutional changes at Engine: its first construction and the visions around it (2015); its operation and functioning (2016); and its move to a much bigger space as a way of further professionalizing its aims (2017). Throughout those changes, I worked predominantly with the staff and members of Engine and had little access to those people who manage and account for the makerspace. Perhaps an

'organizational ethnography' (Ybema et al., 2009), which allows a researcher to stay for a long and continuous period of time, could have enabled participation in the daily lives of the people with management responsibilities, aiming at the understanding of further rationalities and global connections around makerspaces. Additionally, research that allows for high mobility could trace the numerous entanglements of making practices through a 'multi-sited ethnography' (Marcus, 1995) by following global practices of making and hacking. Global connections through travelling entrepreneurs enmeshed in transnational accelerators, conferences, etc., or other specific sociomaterial techniques that are packed into ideas and "management recipes" (Orlikowski and Scott, 2008, p.464) could be followed to illustrate how those global connections frame the daily practices of makers and other innovative people.

Again, my research combines multiple experiences, solely within Nairobi and with people and materialities only referring to various global places that also lie 'outside' of Nairobi, be it "Silicon Valley", "China" or "Kisumu". Thus, the paper builds on the global discourse about 'revolutionary makerspaces' and offers glimpses into local narratives and practices being resistant, supportive and contradictory, but entangled. When using the term 'narrative', I follow Czarniawska (2004, p.27): "Everything is a narrative or at least can be treated as one. Usually, however, a narrative is understood as a spoken or written text giving an account of an event/action or series of events/actions, chronologically connected. Indeed, it is easy to say what is not a narrative even if it is a text: a table, a list, a schedule, a typology."

MAKING NEW TECHNOLOGIES IN NAIROBI: THE REVOLUTIONARY PRACTICES

Looking at the discourse on makerspaces, the majority of academic and popular literature praises the advantages of digital fabrication for education (Blikstein, 2013; Benton et al., 2013; Halverson and

Sheridan 2014; Martin, 2015; Vossoughi and Bevan, 2014) and the inclusion of grassroots people in technological development through makerspaces (Kera, 2012; Smith et al., 2013). It seems that schools, public libraries or other educational institutions see the practices of making and a specific "maker mindset" (Martin, 2015, p.37) as tools that are highly inclusive for children and families alike (Benton et al., 2013, p.31; Sivek, 2011, p.12). They do so by enabling children in areas of creativity, problem-solving, collaborative work, experimenting and accepting failures (Blikstein, 2013, p.18; Vossoughi and Bevan, 2014, p.46). Despite education, makerspaces and hackerspaces are seen to spur the democratization of science development through the participation of grassroots people in experimenting with scientific knowledge and technologies (Kera 2012; Lindtner, Hertz and Dourish, 2014, p.4). The possibility of a subsequent increase in "user control over technologies" shows the appreciation of the political power of makerspaces and hackerspaces and the importance of raising awareness about the developer-technology-user relations (Maxigas, 2014, p.11). In general, the majority of the literature on makerspaces predominantly contains either the hype about innovative spaces that will foster education, or the call to use the political power of making[5].

Many euphorically described advantages of makerspaces are also experienced by individuals using the makerspace Engine in Nairobi: most of Engine's users call it "revolutionary" because it allows for learning through practice, and embodies approaches contrary to those of the engineering education offered at universities. Many engineering students and potential employers complain about the outdated curricula of Nairobi's universities: "The universities in Kenya are too bureaucratic and not teaching the right stuff in the classes. [... S]tudents still learn the same computer languages that they were being taught eight years ago, even though current technology has changed. The people [prepared for working in a technological company] are usually the ones that are self-taught" (Hersman,

2017, p.52). Therefore, it is not surprising that all members of Engine are characterized by an extreme will to learn and build something in practice. One of the interns at Engine told me what he likes most about working at the makerspace:

In Kenya, what normally happens is that we have repairs, which is the main work offered out there. So for an engineer, you study, you understand a lot of concepts, but the only work that you get is to maintain what others have designed. [...] I would like to work in places which deal with more interesting and challenging things, like coming up with solutions, again empowering others to come up with solutions, which is exactly what is being offered at [Engine]. [...] I think [Engine] is one of the best places on earth.

(former intern at Engine, interview, 2016)

The intern at Engine feels “empowered” by prototyping with digitalized machinery because, as a studied engineer, he strives for a different job than just repairing imported goods. As a person who feels empowered by developing technology to solve problems in his respective context, this intern embodies the dominant representation of makers. Sivek (2011, p.21) analyzed the discourse created by the most influential magazine on making, MAKE Magazine, and found out that “the contemporary maker is elevated to a societally significant problem solver, working on behalf of the nation and world, and within a community of makers, but still an individual who determines his or her own path”. Therefore, making constitutes “a proactive response to social and economic change” (Ibid., p.23). Scholars who are focused on making and subjectivization have thoroughly explored how people adopt a maker identity and what it means for them (Davies, 2017; Lindtner, 2013; Toombs, Bardzell and Bardzell, 2014), as well as how global discourses on innovation and making subjectify people into “entrepreneurial citizens” who are “celebrated in transnational cultures that orient

toward Silicon Valley for models of social change” (Irani, 2015, p.801). This paper makes a small contribution to these debates by elucidating, as stated in the methodical part above, multiple and contradictory narratives about and of makers in Nairobi that show the impossibility of talking about a generalized archetype of the ‘Kenyan’ – or, worse, ‘African’ – maker.

Countering Eurocentric Narratives on Technological Innovation

When looking for literature specifically on makerspaces in the Global South, the results are scarce. Historical accounts on the emergence of makerspaces omit places in Sub-Saharan Africa, as these places often do not have a long history of institutionalized making. Thus, the genealogies of hackerspaces and makerspaces focus on the characterization of makers forming a counterculture or Do-It-Yourself/repair movement against capitalist structures in post-Fordist environments (Maxigas, 2012; Sivek, 2011).[6] Therefore, it seems that the majority of literature around making and innovation reflects the hegemonic story about the relation between the Global South and technology:

The story of the [Global South] and technology if it is told at all is one of transfer, resistance, incompetence, lack of maintenance, and enforced dependence on rich-world technology. Imperialism, colonialism, and dependence were the key concepts, and the transfer of technology from rich to poor, the main process [that have been focused on].

(Edgerton, 2007, p.92)

The underlying assumptions of a linear exchange between a putative center of innovation, which is the Global North, and a periphery that consists only of consumers of innovation, lying in the Global South, can be traced back to communications professor Everett Rogers (2003), who published his theory of “Diffusion of Innovations” in 1962. Based on his work, the diffusion model was used to explain

that people in the Global North innovate, while people in the Global South adapt technology, if anything (Rogers, Ascroft and Röling, 1970; Havelock, 1979). By now, the theory has been highly criticized by various scholars, e.g. for its assumption regarding the universal applicability of technology due to intrinsic properties, and the conviction of a linear exchange (Akrich, Callon and Latour, 2002; de Laet and Mol, 2000).

Nevertheless, the fight against the clichés of the superiority and universality of knowledge and technology coming from the Global North (and predominantly from Silicon Valley) still defines the daily lives of technological developers in Nairobi. The stereotypes of putative dichotomies that are created through academia, mainstream media and developmental practices resemble a postcolonial continuity. Thus, a makerspace like Engine is not only ‘revolutionary’ because it empowers individuals and hardware start-ups, but because it is also used in a collective act to create international awareness around technology production in Nairobi. This awareness is often deployed to turn the Eurocentric innovation discourse upside down by showing an environment that differs from the stereotype of a passive Global South, which only acts as a recipient of technologies from the Global North. The former Head at iHub Research emphasized that through all the people who are producing stuff in Nairobi, “the image is starting to change and people are starting to realize that we also have a place in this changing tech scene, here in Nairobi and globally and in the region.” (tech expert and researcher, interview, 2015). Avle and Lindtner (2016) also wrote about one of their interlocutors in Accra who explained that it is important to create awareness around technology production in Sub-Saharan Africa to deny an image of passive people: “[...] it is about Africans taking ownership of the problems of Africa. It’s about Africans creating the solutions that help solve and lift the multitudes of Africans who are in poverty out of that ... It’s no longer about sitting down and having Westerners come in to the continent to do charity.” (Gregory Rockson cited in Avle and Lindtner, 2016, p.2233). Furthermore, a researcher

and education tech expert in Nairobi scrutinizes the question of ownership. In her opinion, it is important to interfere in the dominant narrative about tech in Kenya – especially in academic discourses – because they are driven by people who are not a daily part of the innovation scene in Nairobi: “the fact that [...] we were able to access that research by participating in the conference, helped us to correct the narrative [...] of what’s being told out there” (education tech expert, interview, 2015).

“Made in Africa, for Africa” - Two Sides of a Coin

In addition to going to conferences on innovation, giving TED talks and writing blog articles, there is another specific strategy to create visibility for technological knowledge production and to fight against the superiority and universality of knowledge and technology coming from the Global North: namely, to brand products and projects “Made in Africa, for Africa”. Be it an internet modem, water barrels or a makerspace – all are branded as being innovated and produced in African countries for African contexts. “Made in Africa, for Africa” is more than a brand for technology developed in Nairobi; it is the claim for expertise, for having the expert knowledge about what is best for one’s own context and what to make and build for it. One example of this kind of marketing is used by the hardware company BRCK. Advertising their BRCK internet modem as ‘born in Africa and made for Africa’ shows the conviction of the developers: “you can’t effectively engineer for the realities of Africa if you don’t experience the realities of Africa” (Walton, 2014). Asking the CEO of BRCK what the “realities of Africa” are, he answered that “only [...] if you get dirt under your fingernails, you get thorns in your legs, you get sunburn on your face and really deal with the harsh realities of Africa, you will understand Africa” (CEO of BRCK, interview, 2015). For BRCK’s employees, their internet modem is “a solution that is born out of Africa under the specific situation here” (Reg Orton cited in Manske, 2014, p.7). Those statements and the advertisement show the conviction of the developers at BRCK: contextualized

design of technologies is important, because designers from abroad are not able to grasp the context specificities of Kenya.

Despite the idealism of presenting a place in the Global South that is able to develop high-tech solutions for its local needs, independent from so-called centers of innovation, the slogan “Made in Africa, for Africa” nevertheless evokes exoticized and generalized images of an ‘Africa’. If we look at the advertisement of the already-mentioned BRCK, we see the presentation of a technical device that is robust like a brick, works (among other functionalities) like an internet modem and is especially made for “harsh environments” (Mushakavanhu, 2017). The motivation to develop such a device is the fight against poor internet connections, which shapes daily life, according to its developers (Shapshak, 2017). Therefore, BRCK developed a modem that works even without electricity in case of power cuts, due to its own battery. Additionally, it is built to be repellent to water and dust. BRCK’s marketing implies that all of Africa is a “harsh environment”, meaning that the continent is characterized by hot sun, dust, tropical rain and disrupted connectivity.

This specific advertisement and its descriptions of the ‘local’ context remind us of Binyavanga Wainaina’s (2006) ironic critique on “How to write about Africa”: “[Africa] is hot and dusty with rolling grasslands and huge herds of animals and tall, thin people who are starving. Or it is hot and steamy with very short people who eat primates.” Thus, ‘real Africa’ includes mud huts, starving, helpless, opinionless, uneducated humans, who have their hands outstretched to the benevolence of the caring westerner. Referring to such descriptions while advertising technology “Made in Africa, for Africa” evokes colonial imaginations of a generalized and ‘exoticized’ (Said 1979) ‘Africa’, which is constantly compared and ‘othered’ against sites in the Global North. Referring to concepts of ‘othering’ following Gayatri Chakravorty Spivak (1985), I want to show that reducing ‘others’, in this case the target group for a technology, to inferior stereotypes means that

knowledge and technology belongs to the ‘master’ (Spivak, 1985, p.256), who would be the tech companies in this case. According to Jensen (2011, p.65):

Such processes imply reduction and essentialization in the sense that those who are othered are reduced to a few negative characteristics. Consequently, [...] othering [are] discursive processes by which powerful groups, who may or may not make up a numerical majority, define subordinate groups into existence in a reductionist way which ascribe problematic and/or inferior characteristics to these subordinate groups.

In the specific depiction of ‘local needs’ in the BRCK example above, we see that ‘local’ seems to represent a whole continent, which is imagined as harsh, wild and rural, and the ‘needs’ as needs of rural and disadvantaged societies. Thus, potential customers in African countries become homogenized and essentialized as poor and in need of technological solutions. Further, the context of the technology’s target group is generalized as a rural environment full of deficits (Nduka-Agwu and Bendix, 2007, p.9). Thus, the claim for contextualized design and technology – “Made in Africa, for Africa” – seems to stage African countries as active technological producers on the one side, while evoking and (re)producing the hegemonic imaginations about a lagging Africa on the other. The question emerges: why do the critics themselves use the dismissed tropes of ‘an Africa full of deficits’? The answer cannot be found in “the harsh realities of Africa” (see above), but amidst the harsh realities of business life: namely the acquisition of money.

MAKING NEW TECHNOLOGIES IN NAIROBI: THE RESTRICTING IMAGINATIONS

In the previous part of the paper, we saw that Nairobi’s tech scene is presented and perceived as

being revolutionary for two reasons: it empowers manufacturers and hardware entrepreneurs to tackle prototyping challenges, and it counters stereotypes of the Global South as a passive place that is dependent on technology from the Global North. In the midst of a revolutionary vibe that represents a collective agenda with individuals who determine their own paths (as Sivek [2011, p.21] describes the representation of makers), techies face the problematic acquisition of money. The following section illustrates the crux of the paper, namely how funding issues in Nairobi differentiate its tech scene from other places in the world by showing postcolonial trajectories of ‘dancing to tunes’ and of ‘strings played out’ and how those dependencies lead to the constant balancing between the aims of start-ups and tech-oriented people and the investors’ visions.

Money with Strings Attached

As already stated in the introduction, people who work to develop new (hardware) technology face various challenges in Kenya. Besides the high taxes on imported goods and thus the difficult access to resources and machines to prototype, one of the toughest parts of working on a technological idea is gaining the funding to work on it.[7] Until now, the priority for local investors in Kenya has lain in the property market. A start-up owner explains why it is difficult to find local funding: “It’s difficult to get angel investors because the property market returns fifteen percent and it’s quite a low risk. So no one is ever going to invest in higher risk and lower return” (start-up founder, interview, 2017). Therefore, most of the funds for tech start-ups come from internationally owned firms and organizations that intentionally seek to invest in technological innovations (Njugunah, 2016). In general, the tech scene in Nairobi is characterized by a high number of international private investors, venture capitalists, philanthropic foundations and development agencies that fund innovative people and their ideas. Furthermore, almost all big technology companies, like Microsoft, IBM, Google, Intel, etc., have established their regional offices in

Kenya by now (Marchant, 2015, p.8).

The visions of those international funders circulate predominantly around the transformation of Kenya’s economic and societal status by use of technology. This vision can be exemplified with a quote from a funder of Engine: “We are confident that [Engine] will transform the environment for invention in East Africa. It will provide a much-needed space for inventors to talk, build, test, and ultimately take their ideas to market. We anticipate that inventions born at [Engine] will make people’s lives better and bolster local economies for generations to come” (The Lemelson Foundation, 2014). Thus, the expectations of investors and donors who financially support start-ups and innovative working places in their early phases focus on the social impact of new technologies. “The kind of foundations which fund around hardware development, they see very straight what they want done. They have straight conditions like ‘this is what we are looking at, if you fulfill this, we are going to give you funding’. Of course for any development agency social impact is key. They wouldn’t just fund a technology thing” (mechanical engineer, interview, 2015).

Not only development agencies but also private investors who fund tech development in Nairobi use a philanthropic stance in their funding. Pearson and Avle (2016) describe the rhetoric of Google and Facebook as “aid language” when talking or writing about their investment in the Global South. They draw “from human rights-based and international development narratives that emphasize global imbalances and position the global south as recipients of the north’s largesse and expertise” (Ibid., p.1). In the specific context of Nairobi, Marchant (2015) has studied the assimilation of visions from private companies and development agencies when legitimizing investments in technological ideas. She claims that the global trend of corporate social responsibility is only a partial answer to the phenomenon of the social-impact focus of profit-oriented tech companies (Ibid., p.11). The other part is that “the current pervasiveness of interest in technological innovation among

development practitioners makes it difficult for the technological innovation sector to disassociate itself from such development objectives” (Ibid., p.10). Thus, it seems that multinational companies do have to refer to social impact in an innovation context, which is dominated by development agencies and NGOs.

This entanglement of private investors and philanthropic donors and their convergence in social-impact aims can be illustrated in a pitching competition in Nairobi in 2015. I sat in the audience and my Kenyan research partner, who is a mechanical engineer, sat in the jury. Other than her, everyone else in the jury was German, representing three companies, the embassy and three foundations. Looking at the jury, the power asymmetry in terms of who grants funds seemed clear. Along with an entertaining support program with salsa dance shows, food, etc., five projects were pitched. The prizes were not declared until the award show took place: every winner would win a German-language course and a monetary prize between five hundred and two thousand Euros, which was only allowed to be used for that particular award-winning idea. When I looked over the jury’s scoring sheet and saw their guidelines for judging, what seemed remarkable to me was that out of a total of twenty points that could be given to rate every project, ten were assigned to the criteria “Originality of the Innovation and demonstrated creativeness” and “Impact of the innovation”. The other 50% of the scores were divided between “Practicality/Viability of [the project’s] application”, “Market Opportunity” and “Applicability” and seemed to be secondary criteria. Thus, according to the “Guidelines for judging of projects”, questions about the uniqueness of the idea and the possibility of a “fundamental change in processes on the well-being of the community” were considered as more significant than questions of competitive advantage, clear identification of target consumers and sustainability of the project itself. The social impact of a technology is thus more important for the decision to fund an idea than mere for-profit business logics.

Negotiating Funders’ Visions of Technology with Social Impact

Due to international investors focusing on technology with social impact, many tech developers I talked to in Nairobi problematize the prevalent expectations and imaginations of technological innovations coming from Kenya. One of the leading tech experts in Nairobi characterizes the investor-developer relations as follows:

A lot of the money we’ve seen either in development projects, private companies’ investment, VC, angel investing, has been very Americentric. When it comes with Americentric values, it comes with an Americentric thinking. [...] American money just wants to know how you change the world. [...] So, it’s all about whatever centric values this money is being attached to. There is no money that doesn’t have strings attached.

(tech expert and researcher, interview, 2015)

Those “strings” or imaginations of funders lead to restrictions of who and what is worth of funding. A start-up founder confirmed that it is a must to integrate social impact into the business model to gain funding. According to him, all funders and investors in Nairobi are “impact investors”:

They want nice stories and photographs. Because of that it’s not good enough to have a sustainable business that employs people and you make some money and you are not reliant on grants. That’s my definition of impact but for an impact investor, they want you to save the world and reduce carbon emissions and increase access to energy. So the bar is actually higher for companies to get investment here than it is in Silicon Valley.

(head of engineering at a start-up, interview, 2017)

Another research partner of mine explained how investors aiming for social impact set their own milestones and pester start-ups to achieve them: “They want to know, they want to be sure, they want you to write a lot of literature around your projects and all that. So they are quite conditional” (CEO of an industrial manufacturing company, interview, 2015). Those personal experiences from tech entrepreneurs in Nairobi illustrate what Kish and Fairbairn (2017) wrote when analyzing impact investors (especially those investing in a specific farming project in Ghana): that telling stories about the “compassionate dedication to pulling people out of poverty” is the only means of “how to measure seeming intangibles such as social impact” (Ibid., p.10). Nevertheless, impact investor ethics center the value systems of the investors themselves, with little (if any) discernible input from broader communities involved or impacted by their work. Their cultural reference points and performative modes of self-fashioning as financiers who ‘do good while doing well’ can end up erasing the very subjects they purport to serve. (Ibid., p.16)

Thus, if a technology project promises to achieve an extrinsically pre-defined social impact, it has a higher chance to gain funding. It seems that the researched Kenyan start-ups and their ideas are not treated as potentially self-reliant small businesses, but as possible success stories about technological impact in Kenya. The effects of being dependent on the values and visions of financial investors are manifold: a developer is not ‘allowed’ (or financed) to develop tech without a certain social impact, and the supported start-ups and their products are used as successful stories to tell [8].

Nevertheless, business life requires the technological makers to get their projects funded. Thus, they developed several strategies to cope with the requirements and tech-deterministic visions prevalent in their context. An interlocutor who constantly seeks funds for research projects around tech explained the strategy of using “different languages”, depending on what the potential money

fundors would like to hear – even if that means promising to change the world in a tech-deterministic way. Further, she said that handling the various worldviews of funders “calls for patience sometimes, because you are going to deal with a lot of Eurocentric perspectives, you are going to deal with people who are still navigating the idea of Africa, the poor Africa, the lacking Africa, this Africa not rising for all” (tech expert and researcher, interview, 2015). Some entrepreneurs I spoke with use a more direct way of handling problematic worldviews. The founder of a hardware company (interview, 2017) called it “push back” and explained their start-up ideology:

Yeah, our business is helping access to energy. It’s potentially helping to reduce a lot of emissions, potentially helping people with health problems, but we never sort of lead with the impact. We look more at treating our customers like customers first. Rather than cases that we need to help. [...] We do a push back when someone says “I want you to measure how long someone saved walking for fuel and impact on xyz”. Sometimes, we say, “Rather than measuring impact, let’s talk about what you, funder, cook with at home. Do you cook with a cook stove with charcoal? Do you have a solar stove? No.”

(Ibid.)

Another push back would be to “limit the number of funders that can come and visit someone’s home. A lot of funders say ‘I want to visit a customer’” (Ibid.). Despite those coping strategies, tech people are still dependent on getting funds to pursue their work. Thus, being in the midst of such funders’ visions, tech developers have to constantly negotiate between their impulse to criticize the investors’ assumptions of a lagging Kenya and the obligation to talk about societal progress through technology in order to be supported financially. “We try our best to push back as much as possible. But we also have to be sometimes realistic that if there is no other

funding and there is a certain narrative required, we do grit our teeth” (Ibid.).

MAKING NEW TECHNOLOGIES IN NAIROBI: THE PERFORMANCE OF POVERTY

As we have seen, the imaginations of funders regarding a specific kind of helpless ‘Africa’ can have severe consequences for technological developers in Nairobi, such as the need to follow unwritten rules of how to behave, produce and discuss technological innovation. Besides the pressure on individuals, start-ups and places of innovation, the circumstances described also have several performative effects. In the final part of this paper, I would like to draw on Butler’s (2010) latest notion of performativity and show that the dominance of social entrepreneurship practices in a postcolonial context implies a reproduction of (post)colonial imaginations and, thus, processes of “othering” (Spivak 1985) and the performance of poverty.

The belief, as embraced by the international funders and investors in Nairobi, that tech can solve social problems has already been criticized by various scholars. The origin of this belief is predominantly ascribed to Silicon Valley. Evgeny Mozorov (2013), one of the most vocal critics of Silicon Valley, claims that the technological scene is pervaded by the “ideology of solutionism”, which he describes as “an intellectual pathology that recognizes problems as problems based on just one criterion: whether they are “solvable” with a nice and clean technological solution at our disposal” (Ibid.). He claims that not all problems defined by tech companies are real problems, and that problems with structural or fundamental reasons might need greater institutional intervention and not just “quick technological fixes” (Ibid.). Silicon Valley seems to be a vital promoter of social entrepreneurship while boosting “the idea that entrepreneurship is a catch-all solution, and that a startup culture is the best way to solve any problem” (Marwick, 2013). Dey and Steyaert (2010, p.88) mention that social

entrepreneurship has become a grand narrative,^[9] which entuses the media, policy makers, as well as academia. They describe the narrative as “an individualized, messianistic script that incorporates a model of harmonious social change” (Ibid., p.87), whereby the social entrepreneur becomes the active creator and its social context stays passive and awaiting. For Dey and Steyaert, the most problematic feature of social entrepreneurship as a grand narrative is its use as a “general problem-solving blueprint [...] that is applicable to any type of context, historical, cultural, and political” (Ibid., p.89).

Although the belief in the ability of social entrepreneurship and technology to solve all problems is a global phenomenon, it seems that its application in postcolonial contexts implies a reproduction of (post)colonial imaginations and thus, processes of “othering”. As technology with social impact presupposes a (social) problem that should be solved, the focus on social entrepreneurship in Nairobi presupposes that only social problems exist, without considering other possibilities, such as innovating technology for industrial processes. Thus, the dominating social-impact logic applied by international funders of tech innovation in Nairobi and the marketing strategy ‘Made in Africa, for Africa’ perform colonial tropes of exoticized and disadvantaged images of an “Africa”. Those funders’ imaginations and the hegemonic belief in progress through technology enforce parameters of what can or should be developed in Nairobi for Kenyan customers and what not. Therefore, start-ups, makerspaces and individual tech developers are pushed into building devices that focus, e.g., on customers living in rural Kenya, even if they would rather avoid a reproduction of colonial stereotypes and “dancing to the tunes” of ‘othering’ their daily life contexts.

For this reason, I call the development of technology with social impact based on generalized and exoticized imaginations of specific customers and their contexts in an African country a performance of poverty. By referring to Butler’s (2010) socio-

material notion of performativity, I want to emphasize that relations such as those between investors and developers, boundaries between a putative Global South and North and norms of what to build and what not, are not pre-given, but enacted or “invented”, as Butler says. “Norms are in the process of being elaborated, adapted for new purposes, and their continuing life, even their adaptability, depends on the inventiveness by which they are produced time and again” (Ibid., p.154). The reiterative process of performing deficient environments by building technology that should have social impact on broad problems like poverty includes the constant negotiation between the start-ups’ and developers’ business models and technological ideas and the investors’ aims and visions. Thus, although actors in Nairobi criticize the dominance of international imaginations of their contexts, they are also used and reinforced by the same actors (people, start-ups or organizations) to gain money and satisfy investors. Avle and Lindtner (2016, p.2234) also found out that the people they have worked with in Accra and Shenzhen “challenged the notion that the west was the supposed center of contemporary design and innovation, while they also productively leveraged the discourse on innovation at the periphery for their entrepreneurial practice”. Those performative practices – of both changing the discourse on a lagging Africa as well as developing technology to solve poverty issues – materialize and stabilize^[10] the norms of social impact in Nairobi’s tech scene.

CONCLUSION

In this paper, I showed two sides of the emerging maker and hardware scene in Nairobi. First, I illustrated the euphoria about “revolutionary” spaces of technological development regarding educational and work possibilities – be it in academia or in the statements of members of the tech scene. Furthermore, I elaborated that the euphoria has an additional reason, which is deeply rooted in (post)colonial history: namely, the possibility to fight stereotypes of a Sub-Saharan

Africa that is dependent on technology from the Global North. These stereotypes are fought by creating awareness around Nairobi as a site of tech development that is globally comparable. In this regard, the branding “Made in Africa, for Africa” is used to position one’s “work as previously outside and now participating in a global market” (Avle and Lindtner, 2016, p.2241).

Second, I showed that, in the midst of the idealism of raising awareness about knowledge production in Nairobi, techies are not faced with “the harsh realities of Africa”, but rather the harsh realities of business life: the acquisition of money. By drawing on further research insights, the continuing postcolonial power-asymmetries were depicted as manifested in the relations between international investors/funders and start-ups/makers. The monetary relationships include more than financial investment: they include negotiations between the funders’ moral requirements based on tech-deterministic social-impact aims and the start-ups’ own understandings of impact, technology and business models. By looking at the imaginations of global investors and the branding of technology that is developed “for Africa”, it becomes clear that the need to build technology with social impact ‘others’ potential customers in Kenya as people in need of solutions. Customers in rural Kenya are predominantly targeted and, thus, the imaginations of rural and poor societies are reproduced. ‘Africa’ as a whole becomes generalized and exoticized by adhering to stereotypes that ‘other’ local contexts in relation to sites in the Global North. To conclude, I called the reiterative practices entangled in global discourses on social entrepreneurship, the investors’ (post)colonial imaginations of ‘Africa’ and the marketing of technology “for Africa” and its “local needs” a performance of poverty, whereby norms of what can or should be developed for Kenyan contexts – and what not – are performatively stabilized.

In respect to the Special Issue’s topic “The Institutionalization of Shared Machine Shops: New Spaces, Networks + Practices”, we can conclude

that the emergence of makerspaces throughout the Global South often means an institutionalization and formalization of already existing manufacturing practices. These new spaces of making create various prospects, such as job opportunities. Nevertheless, with institutionalization comes a danger of homogenization; not only the numerous activities and visions of making, which range from activist to commercial or both at the same time (Schrock cited in Davies, 2017, p.21), could be singularized. But especially in a post-colonial context, where for-profits and nonprofits unite in a social impact chorus, it is crucial to not leave makerspaces and practices of making prone to the formalization of the same old imaginations that have haunted African countries since European explorers and colonialists invaded the continent. Therefore, de la Chaux and Okune (2016, p.286) advocate for “a more explicit articulation of the specificities and visions associated with technology entrepreneurship [in Kenya, so that] nonlocal actors [are able] to root their expectations and perspectives in local realities rather than in unexamined hopes and expectations”. Thus, as long as generalizing imaginations of contexts in Africa are not challenged thoroughly, and the respective experts in Nairobi are not listened to or, more importantly, are in charge of investment decisions, the “revolutionary” practices around making and innovating in Nairobi remain restricted. To end on an even more passionate note, I refer to Kish and Fairbairn’s (2017, p.16) beautiful claim:

To counteract these monovocal narratives, new discursive spaces of dissensus and political levers for contestation must be opened up to hold these investors accountable to the populations impacted by their work.

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NOTES

[1] Braybrooke and Jordan (2017) argue that, although practices around making and innovating in places in the Global South have “been going on both well before, and also at the same time, as the [maker] movement’s rise in the West” (Ibid., p.30), they were neglected by the dominant Eurocentric narratives around innovations and their origins.

[2] The name has been altered in order to accomplish a minimum of anonymity.

[3] iHub is one of the largest and most prominent Technology Hubs in Sub-Saharan Africa.

[4] Although I’m reproducing the usage of ‘Africa’ as a single location by showing you specific quotes, I distance myself from that use and underlying conviction that a whole continent can be generalized to a homogeneous context and environment.

[5] It should not be left unsaid that various scholars already scrutinize the praised promises of makerspaces and making. Throughout the paper, I will refer to some of them.

[6] I would like to acknowledge those scholars who, in their own ways, provide detailed and contextualized accounts regarding makerspaces by also focusing on places other than the Global North. See amongst others: Avle and Lindtner 2016; Braybrooke and Jordan 2017; Irani et al. 2010; Lindtner and Li 2012; Lindtner, Hertz and Dourish, 2014; Smith et al. 2013.

[7] For an elaboration on how policymaking processes during President Mwai Kibaki’s administration could foster (ICT) innovation in Kenya, see Ndemo 2017.

[8]The strain of storytelling about new technologies in Nairobi, namely writing “the right stories” for funders and the public by serving specific imaginaries of science, innovation and technology is elaborated in Coban (forthcoming). See de la Chaux and Okune (2017), for a broader assessment of contradictory views about the availability of capital, the constitution of business skills and viable technology markets between technology entrepreneurs, innovation hub staff and investors.

[9]Although Dey and Steyaert (2010) do not define their understanding of ‘narrative’, they seem to mean written texts, as they scrutinize “how the academic representation of social entrepreneurship can be understood as a political process of narration” (Ibid., p.86).

[10]Performative practices can also be destabilizing through their reiterative manner. In this paper, I only focused on the practices that stabilize a certain discourse.

REFERENCES

Akrich, M., Callon, M. and Latour, B. (2002) The Key to Success in Innovation Part II: The Art of Choosing Good Spokespersons. In: *International Journal of Innovation Management* 6(2): 207-225.

Avle, S. and Lindtner, S. (2016) Design(ing) ‘Here’ and ‘There’: Tech Entrepreneurs, Global Markets, and Reflexivity in Design Processes. In: *Conference for Human-Computer Interaction (CHI)*, San Jose: 2233-2245.

Benton, C., Mullins, L., Shelley, K. and Dempsey, T. (2013) Makerspaces – Supporting an Entrepreneurial System. Co-Learning Plan Series of MSU EDA University Center for Regional Economic Innovation (REI).

Blikstein, P. (2013) Digital Fabrication and ‘Making’ in Education: The Democratization of Invention. In: Walter-Herrmann, J. and Büching, C. (eds.) *FabLabs: Of Machines, Makers and Inventors*. Bielefeld:

Transcript Publishers.

Birkelo, P. (2017) Building Makerspaces for the 4th Industrial Revolution. Source: <https://medium.com/@cpbirkelo/building-makerspaces-for-the-4th-industrial-revolution-be51e5d76e22> [Accessed 05 July 2017].

Braybrooke, K. and Jordan, T. (2017) Genealogy, Culture and Technomyth: Decolonizing Western Information Technologies, from Open Source to the Maker Movement. In: *Digital Culture & Society* 3(1): 25-46.

Butler, J. (2010) Performative Agency. In: *Journal of Cultural Economy* 3(2): 147-161.

Carr, C. and Gibson, C. (2017) Animating geographies of making: Embodied slow scholarship for participant-researchers of maker cultures and material work. In: *Geography Compass* 11: e12317.

Coban, A. (forthcoming) Same, same but different: Storytelling of innovative places and practices in Nairobi. In: Engelschalt et al. (eds.) *Schafft Wissen – Gemeinsames und geteiltes Wissen in Wissenschaft und Technik*. Proceedings of the 2nd conference of INSIST, Munich 2016, SSOAR.

Crang, M. and Cook, I. (2007) *Doing Ethnographies*. London: SAGE Publications.

Czarniawska, B. (2004) *Narratives in Social Science Research – Introducing Qualitative Methods*. London: SAGE Publications.

Davies, S.R. (2017) Characterizing Hacking: Mundane Engagement in US Hacker and Makerspaces. In: *Science, Technology, & Human Values*: 1-27.

Decoloniality Europe (2013) Charter of Decolonial Research Ethics. Source: www.decolonialityeurope.wixsite.com/decoloniality/carter-of-decolonial-research-ethics [Accessed 06 February 2018].

De la Chaux, M. and Okune, A. (2017) The Challenges of Technology Entrepreneurship in Emerging Markets: A Case Study in Nairobi. In: Ndemo, B. and Weiß, T. (eds.) *Digital Kenya – An Entrepreneurial Revolution in the Making*. Basingstoke: Palgrave: 265-290.

De Laet, M. and Mol, A. (2000) The Zimbabwe Bush Pump: Mechanics of a Fluid Technology. In: *Social Studies of Science* 30: 225-263.

Dey, P. and Steyaert, C. (2010) The politics of narrating social entrepreneurship. In: *Journal of Enterprising Communities: People and Places in the Global Economy* 4(1): 85-108.

Edgerton, D. (2007) Creole technologies and global histories: rethinking how things travel in space and time. In: *HoST* 1: 75-112.

Gachigi, K. (2017) Changing gears for the fourth industrial revolution. Source: www.makingitmagazine.net/?p=10250 [Accessed 05 July 2017].

Halverson, E. and Sheridan, K.M. (2014) The Maker Movement in Education. In: *Harvard Educational Review* 84(4): 495-504.

Havelock, R.G. (1979) *Planning for innovation through dissemination and utilization of knowledge*. Ann Arbor: Center for Research on Utilization of Scientific Knowledge, University of Michigan.

Hersman, E. (2017) Conversation #2: Exploring the Ideal Role of Government, NGOs, Angel Investors, and Universities for Technology Entrepreneurs. In: Ndemo, B. and Weiß, T. (eds.) *Digital Kenya – An Entrepreneurial Revolution in the Making*. Basingstoke: Palgrave: 45-54.

Irani, L. (2015) Hackathons and the Making of Entrepreneurial Citizenship. In: *Science, Technology, & Human Values* 40(5): 799-824.

Irani, L., Vertesi, J., Dourish, P., Philip, K. and Grinter,

R.E. (2010) Postcolonial Computing: A Lens on Design and Development. In: *CHI 2010*, Atlanta.

Jensen, S.Q. (2011) Othering, identity formation and agency. In: *Qualitative Studies* 2(2): 63-78.

Kera, D. (2012) NanoSmano Lab in Ljubljana: disruptive prototypes and experimental governance of nanotechnologies in the hackerspaces. In: *Journal of Science Communication* 11(4): 1-5.

Kish, Z. and Fairbairn, M. (2017) Investing for profit, investing for impact: Moral performances in agricultural investment projects. In: *Environment and Planning A* 0(0): 1-20.

Lindtner, S. (2013) *Making Subjectivities: How China's DIY Makers Remake Industrial Production, Innovation & the Self*. Presented at the Eleventh Chinese Internet Research Conference (CIRC11), University of Oxford. Source: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2282420 [Accessed 19 January 2018].

Lindtner, S., Hertz, G. and Dourish, P. (2014) *Emerging Sites of HCI Innovation: Hackerspaces, Hardware Startups & Incubators*. In: *CHI 2014*, Toronto.

Lindtner, S. and Li, D. (2012) Created in China: The Makings of China's Hackerspace Community. In: *Community + Culture*: 18-22.

Manske, J. (2014) *Innovations out of Africa. The emergence, challenges and potential of the Kenyan Tech Ecosystem*. Vodafone Institute for Society and Communications.

Marchant, E. (2015) Who is ICT Innovation for? Challenges to Existing Theories of Innovation, a Kenyan Case Study. CGCS Occasional Paper Series on ICTs, Statebuilding, and Peacebuilding in Africa (4): 1-22.

Marcus, G.E. (1995) Ethnography in/of the world system: The emergence of multi-sited ethnography. In: *Annual Review of Anthropology* 24: 95-117.

Martin, L. (2015) The Promise of the Maker Movement for Education. In: Journal of Pre-College Engineering Education Research 5(1): 30-39.

Marwick, A. (2013) Silicon Valley Isn't a Meritocracy. And It's Dangerous to Hero-Worship Entrepreneurs. Source: www.wired.com/2013/11/silicon-valley-isnt-a-meritocracy-and-the-cult-of-the-entrepreneur-holds-people-back/ Excerpted by: Sonal Chokshi [Accessed 07 February 2018].

Maxigas (2014) Hacklabs and Hackerspaces: Shared machine workshops. Source: www.researchgate.net/publication/265378243_Hacklabs_and_Hackerspaces_Shared_machine_workshops [Accessed 12 July 2017].

Maxigas (2012) Hacklabs and Hackerspaces: Tracing Two Genealogies. In: Journal of Peer Production 2. Source: <http://peerproduction.net/issues/issue-2/peer-reviewed-papers/hacklabs-and-hackerspaces/> [Accessed 31 January 2018].

Mozorov, E. (2013) The Perils of Perfection. Source: www.nytimes.com/2013/03/03/opinion/sunday/the-perils-of-perfection.html [Accessed 04 January 2017].

Mungai, C. (2015) What's holding back Africa's tech startups? Source: www.weforum.org/agenda/2015/09/whats-holding-back-africas-tech-startups [Accessed 06 July 2017].

Mushakavanhu, T. (2017) African manufacturing its own hardware: BRCK internet in a box. Source: <http://africanarguments.org/2017/01/06/african-manufacturing-its-own-hardware-brck-internet-in-a-box-haller-prize-3rd-place> [Accessed 06 July 2017].

Ndemo, B. (2017) Inside a Policymaker's Mind: An Entrepreneurial Approach to Policy Development and Implementation. In: Ndemo, B. and Weiß, T. (eds.) Digital Kenya – An Entrepreneurial Revolution in the Making. Basingstoke: Palgrave: 339-362.

Nduka-Agwu, A. and Bendix, D. (2007) Die weiße Darstellung „Afrikas“ in der deutschen Öffentlichkeit. Wie ein Kontinent genormt, verformt und verdunkelt wird. In: analyse & kritik – Zeitschrift für linke Debatte und Praxis 37/520: 9.

Njugunah, M. (2016) Kenyan start-ups struggle to get 'reasonable' investors. Source: www.capitalfm.co.ke/business/2016/03/kenyan-start-ups-struggle-to-get-reasonable-investors/ [Accessed 05 July 2017].

Orlikowski, W.J. and Scott, S.V. (2008) Sociomateriality: Challenging the Separation of Technology, Work and Organization. In: The Academy of Management Annals 2 (1): 433-474.

Pearson, B.A.J. and Avle, S. (2016) Chasing the "Bottom Billion": Tech companies and the selling of global connectivity. Source: www.academia.edu/31923550/Chasing_the_Bottom_Billion_Tech_companies_and_the_selling_of_global_connectivity [Accessed 10 July 2017].

Rogers, E.M. (2003) Diffusion of Innovations. New York: Free Press [first published in 1962].

Rogers, E.M., Ascroft, J.R. and Röling, N.G. (1970) Diffusion of innovations in Brazil, Nigeria, and India. East Lansing: Michigan State University.

Said, E.W. (1979) Orientalism. New York: Vintage Books [first published in 1978].

Shapshak, T. (2017) How Kenya's SupaBRCK Aims To Solve Africa's Internet Problems. Source: www.forbes.com/sites/tobyshapshak/2017/03/07/how-kenyas-supabrck-aims-to-solve-africas-internet-problems/2/#1a7ad1221270 [Accessed 14 June 2017].

Sivek, S.C. (2011) "We Need a Showing of All Hands": Technological Utopianism in MAKE Magazine. Faculty Publications: Linfield College. Source: http://digitalcommons.linfield.edu/mscmfac_pubs/5

[Accessed 12 July 2017].

Smith, A., Hielscher, S., Dickel, S., Söderberg, J. and van Oost, E. (2013) Grassroots digital fabrication and makerspaces: reconfiguring, relocating and recalibrating innovation? University of Sussex: Science and Technology Policy Research, Working Paper Series SWSP 2013-02.

Spivak, G. (1985) The Rani of Simur. In: Francis Barker et al. (eds.) Europe and Its Others. Proceedings of the Essex Conference on the Sociology of Literature: 1. Colchester: University of Essex.

The Lemelson Foundation (2014) The Lemelson Foundation funds establishment of pre-eminent design and prototyping facility in East Africa. Source: www.lemelson.org/resources/news/lemelson-foundation-funds-establishment-pre-eminent-design-and-prototyping-facility [Accessed 05 July 2017].

Toombs, A., Bardzell, S. and Bardzell J. (2014) Becoming Makers: Hackerspace Member Habits, Values, and Identities. In: Journal of Peer Production 5. Source: <http://peerproduction.net/issues/issue-5-shared-machine-shops/peer-reviewed-articles/becoming-makers-hackerspace-member-habits-values-and-identities/?format=pdf> [Accessed 19 January 2018].

Ushahidi (2017) www.ushahidi.com/about [Accessed 20 January 2017].

Vodafone (2014) Vodafone M-Pesa comes to Europe for the first time. Source: www.vodafone.com/content/index/media/vodafone-group-releases/2014/m-pesa-romania.html [Accessed 11 July 2017].

Vossoughi, S. and Bevan, B. (2014) Making and tinkering: A review of the literature. Successful Out-of-School STEM Learning: A Consensus Study, Board on Science Education, National Research Council. Source: http://sites.nationalacademies.org/cs/groups/dbasseite/documents/webpage/dbasse_089888.pdf

[Accessed 26 July 2017].

Wainaina, B. (2006) How to Write about Africa. In: Granta Magazine 92. Source: <https://granta.com/how-to-write-about-africa/> [Accessed 10 July 2017].

Walton, P. (2014) The Case for Engineering the BRCK in Africa – Part 2. BRCK Blog. Source: www.brck.com/?p=285 [Accessed 07 July 2017].

Ybema, S., Yanow, D., Wels, H. and Kamsteeg F.H. (eds.) (2009) Organizational Ethnography: Studying the Complexity of Everyday Life. London: SAGE Publications.

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MAKERSPACES AND URBAN IDEOLOGY: THE INSTITUTIONAL SHAPING OF FAB LABS IN CHINA AND NORTHERN IRELAND

Pip Shea, Xin Gu

Makerspaces—specifically those with a focus on digital fabrication and physical computing—are emerging as symbols of social and economic change in many cultures. Much of the empirical evidence that provides details of this phenomenon has been gathered in neo-liberal market economies in Europe and North America. Existing findings have helped situate makerspaces as sites that emphasise ‘commons based peer production’ underscored by non-proprietary ‘gift economies’ (see Gershenfeld 2005, Anderson 2012, Troxler 2013, Kostakis et. al 2015). These narratives have been expanded by findings that reveal how participation is shaped—and often impeded—by the communities, platforms, and policies surrounding makerspaces (see Alper 2013, Toupin 2014, Moilanen et al 2015, Shea 2016). This paper contributes to the literature through an analysis of the institutional arrangements of Fab Labs in China and Northern Ireland. It argues that processes of institutionalisation within these makerspaces are shaped by the specific urban ideologies they are bound to. Fab Labs in Belfast and Derry (Northern Ireland) are deployed as facilitators and enablers of unification processes in a post-conflict society, while Fab Labs in Shenzhen (China) have been manipulated for a specific post-industrial agenda. Institutionalised makerspaces, shaped by these different realities, challenge existing narratives of maker cultures in several ways: first, the development of makerspaces cannot be divorced from top down processes of nation building, as a range of strategic public policy agencies are involved despite low public participation rates; second, makerspaces are a reflection of local values rather than of the ‘commons based peer production’ paradigm of open source culture; and third, commercial corporations are investing in makerspaces to align with public policy paradigms despite uncertain economic returns. The accounts detailed in this paper further expand dialogue towards a more critical and nuanced analysis of makerspaces and global open source cultures.

Keywords: makerspace, Fab Lab, open source, urban ideology, institutionalisation, civic media

by Pip Shea & Xin Gu

INTRODUCTION

‘Commons based peer production’ is a term commonly linked to scholar Yochai Benkler (2002, 2006). It describes a move away from centralised, industrial-scale production, towards production that does not rely on proprietary systems or the managerial imperatives of the firm. It is based on collaboration among networks of people who view their knowledge and labour as a form of ‘gift’. This phenomenon is also referred to as ‘open source

production,’ and is a paradigm which many makerspaces operate within. Due to this phenomenon, makerspaces have been situated as new organisational forms that enable post-industrial production. Attached to this status is a perception that new forms of peer production are more efficient, agile, and egalitarian than formal, centralised modes. Our study contests these established dynamics of open source culture by exposing the institutions that shape and limit Fab Labs in China and Northern Ireland.

We observed top down, institutionalised, organisational structures within makerspaces that

result from the constraints of unique urban ideologies. These ideologies shape individual maker incentives, organisational behaviour, and corporate strategies. Our findings have revealed that makers do not necessarily oppose the commercialisation of their ideas, and that there are a range of intermediary companies facilitating entrepreneurship development for makers, linking them to global venture capital networks. We observed hierarchical organisational tendencies akin to businesses operating within complex political, social, and economic agendas. It became very clear that our case studies are shaped by institutions more than by global maker culture rhetoric: the first from the perspective of the world's largest manufacturer; and the second, from a contested nation-state grappling with a divisive civil conflict. Makerspaces in our cases become symbols of contested meanings and values in specific geopolitical contexts.

Makerspaces in Belfast and Derry (Northern Ireland) and Shenzhen (China) were selected because they represent different experiences in the new era of the production of cities through culture and image: Belfast and Derry are examples of European cities whose economic future is dependent on the reinvention of a new urban image based on civic boosterism. Post-conflict Northern Ireland is in need of a new relationship with urban environments that is capable of attracting new industries and investments. Shenzhen, on the other hand, is experiencing rapid de-industrialisation in its inner-city area. It is seeking to transform its urban image from a 'dirty' mass manufacturing city to a 'clean and fun' city.

This article makes an important contribution to the body of literature that contests the exuberant rhetoric surrounding digital maker cultures. Claims of an emergent 'industrial revolution' (Gershenfeld, 2005; Anderson, 2012) linked to maker cultures have been offset by scholarly investigations linking distributed design and manufacturing flows to labour exploitation (Scholz 2013), diminished scale efficiencies, and intensified consumption (Smith et

al. 2013). Equity challenges in makerspaces include the privileging of historically masculinised practices (Carstensen 2013, Shea 2016), and the difficulties of enacting the conditions for 'hacker agency' (Shea, In Press). Murray and Hand (2015) situate cultures of making in the Global South in opposition to those in the West through the Indian example of 'jugaad', a practice underscored by "economic constraints and lack of resources" (2015 p143). While the assumption that hackers and tinkerers in the US have historically acted alone in their DIY missions is debased by historical links with military funding (Driscoll 2012). The perception that peer production is non-market and non-proprietary has already been called in to question by Kreiss, Finn and Thurner (2011). The premise that the current making moment is a *movement* is also contested, as the societal impact of emergent digital making techniques has been argued to be a fringe phenomenon (Maxigas & Troxler 2014).

Literatures relating to maker cultures in China are emerging. The works of Lindtner (see 2015), grounded in Human Computer Interaction (HCI), were among the very first attempts to understand maker cultures situated outside of neo-liberal market economies. Whilst we agree on the importance of contextualising China's makerspaces in different cultural, operational, and policy paradigms, our focus on the development of maker industries as a new inner city economy to replace traditional manufacturing adopted by post-industrial cities, offers a critical lens countering more technoutopian views. We argue that Fab labs in Shenzhen are used by 'creative clusters' as marketing tools to conceal the new wave of urban gentrification in many post-industrial cities (Gu In press).

Other relevant scholarly investigations of maker cultures include Toupin's survey of feminist hacklabs (2014), Kohtala's propositions of critical making and sustainability in Fab Labs (2017), Alper's work on mixed ability maker cultures (2013), and the status of 'hacking' as a privilege (Shea, In Press). Hielscher and Smith's (2013) literature review of community-based digital fabrication workshops reveal a

nuanced landscape of hacking and making cultures. Hunsinger and Schrock's edited collection, *The Democratization of Making and Hacking* (New Media & Society 2016) also deals with the contradictions of the democratising potential of making, drawing attention to how makers are often complicit in the exploitative practices of neoliberalism and globalisation. They also expose maker culture as forgetful, "in order to find a perpetual sense of novelty in their very existence" (2016). More recently, Smith and Light (2017) have developed a thesis about makerspaces and sustainability, providing further evidence that discourses have become more nuanced in their approaches to understanding these new organisational forms.

This article highlights the shared characteristics of institutional arrangements within makerspaces in the two countries. The research methodology is grounded in the ethnographic paradigm (Hammersley & Atkinson 1995). The researchers have spent time embedded within the makerspaces and maker communities of both case studies. Semi-structured interviews with managers of creative clusters, managers of makerspaces, policy makers, project leaders, and maker participants have been recorded across the two sites. We observed makers performing activities within these two makerspaces. Participant observation data has also been gathered as one of the researchers was directly involved in a Fab Labs NI project.

Field research was initially conducted to identify the strategic significance of digital maker cultures in China and Northern Ireland. The study of Shenzhen began in 2015 when the premier of China visited Shenzhen's makerspaces, cementing state endorsement of maker industries in the country. The study of Northern Ireland emerged through previous research into the role makerspaces play in enabling civic practices and imaginaries (Shea 2015, Shea 2016). Follow up trips and observations were carried out in 2016 and 2017. The investigation is further enriched through observations of specific maker projects, events, and research programs; and analysis of company and policy documents, and

online networks.

FAB LABS AND URBAN IDEOLOGY

Once synonymous with low value products, 'making' can now denote flexible specialisation, high-tech, and high value added. Our case studies provide evidence that makerspaces—shared cultural infrastructure that facilitates these new modes of making—are being prioritised in region-specific policies to diversify their cultural economies. Although this perspective is underscored by economic imperatives, our accounts of institutional influence on Fab Labs in China and Northern Ireland has revealed they are markedly different from makerspaces situated in market-driven economies. In contrast, they are linked to policies that prioritise specific urban ideologies and local aspirations rather than the 'commons based peer production' paradigm.

The makerspaces surveyed in this paper are members of MIT's Fab Lab network. Fab Labs are makerspaces that enable small-scale digital fabrication. An important historical vector in the formation of the Fab Lab model was Professor Neil Gershenfeld's MIT class titled *How to make (almost) anything*. The success of this class was the kernel that led to the Fab Lab model as we know it today. The title of Gershenfeld's class was the precursor to the phrase "anyone can make (almost) anything," commonly used in conjunction with claims about the democratising potential of the maker movement (Anderson 2012). The idea that technology is the great enabler, or source of enfranchisement, is central to the maker culture imaginary. To be part of the Fab Lab network, makerspaces must address the criteria outlined in the Fab Foundation's Fab Charter. This suggests the Fab Lab being a normative model in itself. Our argument contests this through evidence of Fab Labs in contrasting contexts delivering vastly different impacts and outcomes.

Shenzhen is a medium sized city in China's Pearl River Delta industrial zone, in close proximity to the

global trading port Hong Kong. For nearly four decades, Shenzhen led the world in the manufacturing of small electronics, specifically mobile phones. This period was linked to the implementation of Deng Xiaoping's Open Door policy in 1978. The early 2000s saw Shenzhen's manufacturing base challenged by nearby towns. This is partly due to the fact that the majority of Shenzhen's population are mobile residents caught in manufacturing capital flows. This saw many large factories relocate or morph into smaller, more specialised operations to align with investment in the 'Shanzhai' mobile phone market. As Anna Greenspan (2014) has argued, Shanzhai is a response to a Chinese market that was largely ignored by the global mobile phone industry. However, Shanzhai's appropriation of product ideas for local use (often in breach of intellectual property rights) earned Shenzhen a reputation as a 'city of fakes,' which continues to influence perceptions of Chinese manufacturing.

The global financial crisis in 2008 saw further change for Shenzhen as a mass manufacturing industrial city. Over six hundred manufacturing plants were shut down and over fifty thousand workers were made redundant. This sparked fears that Shenzhen, a formerly diverse manufacturing city, was losing its competitiveness. Efforts were then made to reinvent Shenzhen's image, to transform its traditional manufacturing base, and to attract new investments. Following the 2015 release of 'Made in China 2025' [1] by the State Council, hundreds of makerspaces were established in Shenzhen. Makerspaces and the narrative of a maker culture continues to be a key form in this transformation.

The Shanzhai mobile phone industry has made a significant contribution to Shenzhen's GDP. In 2009 the year after the global financial crisis, 179 million Shanzhai mobile phones were manufactured in Shenzhen. The successful transformation of Shenzhen therefore cannot be separated from this manufacturing legacy; however, maker culture has proved an effective counter to negative perceptions

of the practice. Maker culture has been effective for three reasons: first, it legitimises Shanzhai industries by emphasising their disruptive power in relation to established global mobile phone markets; second, maker culture accentuates the grassroots DIY entrepreneurialism of Shanzhai; and third, maker culture evokes a unique form of 'ingenious Chineseness, marginality and independence, and playfulness and critique' (Chubb 2015: 272) creating a new foundation for the emergent 'Created in China' paradigm (Gu, In press).

Maker culture and makerspaces in Northern Ireland are thoroughly entangled with social, economic, and political issues arising from the sectarian conflict that began in the late 1960s. Colloquially known as *The Troubles*, this period was shaped by military and paramilitary violence from groups contesting the political sovereignty of Northern Ireland. The two groups in opposition were those who fought for the reunification of Northern Ireland with the Republic of Ireland, against those loyal to Britain who fought to remain part of the United Kingdom. These two communities are often identified as either Catholic or Protestant. Although violence has subsided, reconciliation is ongoing, and Northern Ireland's makerspaces are actors in this peace process.

The concepts of 'shared spaces' in Northern Ireland has a meaning that is inextricably linked with historical societal separation due to sectarianism. A shared space denotes a place that actively encourages and supports the co-existence of both Catholic and Protestant communities. So, a shared machine shop—or makerspace—by virtue of its status as a shared space, is embedded with the symbol of post-conflict reconciliation. Makerspaces join other shared creative space initiatives—such as artist run initiatives (ARIs)—that play an important role in the civic reconciliation project. Makerspaces in Northern Ireland have previously been established as an enabler of alternative civic activity (Shea 2015). They have also been viewed through the lens of 'agonism', as a way of explaining how the oppositional forces of sectarian politics of Northern Ireland can become productive (Shea 2016).

The institutional influences traced in this paper reveal an array of individuals, organisations, rules, regulations, and contexts surrounding three Fab Labs in China and Northern Ireland.

We have categorised the institutions as primary, secondary, and peripheral to highlight different levels of organisational influence. *Primary* describes institutions or organisations that provide major operational money, support, or guidelines. *Secondary* describes institutions or organisations that provide project money, support, or guidelines. *Peripheral* describes institutions or organisations that have an influence by association.

FAB LABS NI, NORTHERN IRELAND

Institutional arrangements

Fab Labs NI is a not-for-profit organisation based in Northern Ireland that offers programs and services through two digital fabrication labs. It is a direct result of European Union Peace III policy interventions, and is funded primarily through the Special European Programs Body (SEUPB). Also known as the *Fab Lab Intervention Project* (FLIP), Fab Labs NI received an initial operational grant of close to 1 million pounds from the SEUPB in 2011 (Fab Lab Feasibility Study 2016). As such, the SEUPB is situated as having a *primary* influence on Fab Labs NI in this study. The primary local institution of Fab Lab Belfast is the Ashton Community Trust, while in Derry~Londonderry it is the Nerve Centre. The Fab Labs NI project is an intervention that aims to deliver on the following specific peace building criteria, "*Individual Change and Healthy Relationships*" (Ashton Community Trust constitution 2005). It can be viewed as a soft political project that aims to repair and reinvent communities—and perceptions of communities—in Northern Ireland.

Fab Labs NI has received large amounts of operational funding from the SEUPB to respond to significant deprivation in North Belfast and

Derry~Londonderry. Both areas were chosen as sites for Fab Labs due to the disproportionate impact the sectarian conflict has had in both areas. Evidence for these decisions were based on a range of indicators, including deaths and injuries arising from the conflict, free school meal provision, and unemployment (Northern Ireland Multiple Deprivation Measure 2010).

The Ashton Community Trust is a community centre situated in an 'interface' area—a colloquial term for geographic areas where Protestant and Catholic communities live side by side—just north of Belfast's city centre. Ashton is a registered charity and company limited by guarantee, that has a remit to provide "facilities in the interests of social welfare for recreation and other leisure time occupation; (and) the provision of education through teaching, instruction, training, seminars, conferences, the provision of facilities for education or any combination of these." (Ashton Community Trust constitution 2005). The organisational structure comprises a board of directors, a CEO, and eight roles that head the following departments: Community Development, Employment, Victim Services, Childcare, Administration, REAL Project, New Lodge Arts (community arts initiative based around the New Lodge public housing estate), and Fab Lab Belfast. Ashton is audited externally every year and has met the financial probity requirements of a diverse range of supporters whom require various standards and systems for funding applications and acquittals (Ashton Community Trust annual report 2012-2013).

The Nerve Centre in Derry-Londonderry is a creative media arts centre. It is a social enterprise that delivers creative education programs, offers creative production facilities, and programs arts events. It employs 40 staff and has a board of directors comprising of people from industry, the tertiary sector, and the public service. The Nerve Centre was initially a grassroots initiative, having developed as a youth initiated organisation in 1990. The Fab Labs NI project builds on existing work around creative education that the Nerve Centre pioneered in its

early years. The Nerve Centre is also a core partner in the Digital Derry Digital Action Team where the Fab Lab is positioned as an integral element of the Digital Derry strategy for building digital capacity and sectoral development in the North West (Nerve Centre annual report 2012). Active policies governing both Ashton and the Nerve Centre include: Staff selection and Recruitment; Staff Training; Equality of Access; Harassment; Domestic Violence; Health and Safety; Fraud Policy; Quality Policy; Communications Strategy; Anti Bullying Policy; Procedures on Domestic Violence in the Workplace; Volunteer Policy; Child Protection Policy; Anti Age Discrimination Policy; Flags and Emblems Policy; Documentation Retention Policy; Smoking Policy; Hospitality Policy; and, Mobile Phone Policy (Nerve Centre annual report 2012, Ashton Community Trust annual report 2012-2013).

Additional primary institutional influences are the Massachusetts Institute for Technology (MIT) and its associated Fab Foundation network. To be part of the network, Fab Labs must address the criteria outlined in the Fab Foundation's Fab Charter: such as, venues must be open to the public for free or in-kind each week; they must share designs among the wider Fab Lab network; and adhere to the recommended list of Fab Lab equipment. Fab Labs Ireland is an all-Ireland advocacy group that also has a primary influence on the operations and activities of Fab Labs NI.

Secondary institutional influences include the following Northern Irish government departments: The Department of Culture, Arts and Leisure (DCAL), and the Department of Social Development. The Arts Council NI and Craft NI—government organisations charged with supporting arts and crafts activities in the region—are also involved in ongoing project work. Local councils are also involved in the facilitation of programs via in-house 'Good Relations' officers. These government roles flow over the border to the Republic of Ireland as well, evidenced by initial support letters from the local council in County Donegal.

Tertiary institutional involvement includes program evaluation exercises undertaken by Queen's University Belfast (School of Urban Planning), and the use of Fab Lab resources by the Ulster University's International Conflict Research Institute (INCORE). INCORE's Peacebuilding and Technology Laboratory (PeaceTechLab)—based in the FabLab at the Nerve Centre—specifically invites explorations into how technology and new media can be used to enhance peacebuilding practice. PeaceTechLab is a partnership with The Young Foundation, The Agirre Lehendakaria Center for Social and Political Studies in the Basque Country, New York based Culture Shock, and Scensei in Washington.

Organisations that exist on the periphery of the Fab Labs NI operation—but that remain influential—include various social enterprises, colleges, and international operations. Locally, the NI Skillset Media Academy of the North West Regional College is a player, as is the UNISON workers' union. A partnership with Oakgrove Integrated College is worth noting, as integrated education is the name ascribed to schools that are not aligned with Catholicism or Protestantism. It is an important, but rather rare, reconciliation project in Northern Ireland. Fab Labs NI also engage the services of social enterprises such as LOAF catering. Its innovative community-focussed organisational arrangements offer sight-lines for those who come into contact with Fab Labs NI.

Internationally, Fab Labs NI have played hosts to the—oft-cited socially focussed— Mondragon Team Academy. Situated in the Basque region, MTA is a "global network of social innovation ecosystem labs."^[2] Fab Labs NI are also increasingly engaged with international tertiary institutions—particularly in Spain—who negotiate industry placements within the Fab Labs for their students. Fab Lab Nerve Centre's involvement in the Future Artist-Maker Lab beginning in 2015, has established ongoing partnerships with international makerspaces in Limerick (linked to the University of Limerick) and UltraLab Madrid (links with Media Lab Prado).

Maker culture, social technology, and new urban imaginaries

The peace-building project in Northern Ireland is defined by sectarianism and conflict surrounding social, economic, and political difference. The imposition of socio-economic development agendas on local actors underpins approaches to change (Richmond and Mitchell 2011); while civic reconciliation initiatives deemed to favour either Catholic or Protestant communities are commonly contested through organised protest (Murtagh 2011). Despite these geo-political specificities—and its emerging independent economic status^[3]—Northern Ireland has taken several cues from the urban cultural policies of other regions. Belfast’s Titanic building is a classic case of the global ‘creative cities’ trend to build large-scale cultural infrastructure to reinvent city image with the view to attracting foreign interest and investment, while boosting civic pride. This symbol of “the new Northern Ireland” (Ramsey 2012) opened in 2012, the same year Fab Labs NI opened their doors to the public. These cultural economy projects seemingly exist at opposite ends of the policy spectrum: one emerged from an urban planning precedent that had been rolled out across multiple cities globally, the other was an experiment, and grassroots in scope. However, both examples play a role in the development of new urban imaginaries.

The promotion of new urban imaginaries in Northern Ireland is salient considering continued speculation over its sovereignty (linked to ongoing processes of devolution from the UK central government). Its Fab Labs NI project is an important actor in this national rebrand as it positions Northern Ireland as a leader in the field of *social* technology. The Fab Farm project is evidence of this phenomenon. The initiative develops community capabilities to build digital aquaponics farms. Aquaponics uses fish to provide a clean, sustainable and highly efficient environment for the growing of plants. In one project, participants are using their aquaponics farms to provide high quality produce for local

restaurants and artisan markets. The project was recently awarded a UK-wide *tech4good prize*, contributing to a rise in the profile of social technology projects within Northern Ireland. Ulster University’s Peacebuilding and Technology Laboratory (PeaceTechLab)—based in the FabLab at the Nerve Centre—is also part of this push. They aspire to develop “an international model of practice and learning placing Northern Ireland at the forefront of emerging thought around the positive impact of technology in the world.”^[4]

As previously noted, makerspaces in Northern Ireland have been situated as enablers of civic activity, in an era where the very constitution of civic action is diversifying (Shea 2016). This promotion of civics crosses over with makerspaces from market economies, as the rhetoric of self-direction and taking matters into one’s own hands, surreptitiously feeds several neo-liberal agendas. Institutional support of makerspaces can therefore be interpreted as an attempt to use the veil of participation and civic duty to develop productive citizens to serve the national economy.

The multiple institutional influences that have been detailed in this article reveal Fab Labs NI as an organisation fit for small scale projects within a community cultural development framework. This situates their work as *local*, as it responds to the specific needs of the surrounding communities. Projects such as *Temple*, and the *Transitional Justice Jigsaw Puzzle* are two examples of civic reconciliation projects that aimed to represent lived experiences of the conflict. *Temple* was an initiative aimed to re-contextualise contested bonfire rituals performed by both Protestant and Catholic communities in the city of Derry; while the *Transitional Justice Jigsaw Puzzle* engaged women from a contested cultural area of Belfast in digital fabrication processes at the Fab Lab. But despite the Fab Labs NI mission as a socio-economic intervention, it remains an operation that has ongoing benefit to a relatively small contingent. In

the updated Northern Ireland Multiple Deprivation Measure (2017), areas surrounding both Fab Labs—such as Derry City, Ardoyne, and New Lodge—remain in the top ten most deprived Super Output Areas (SOA).

The framing of Fab Labs NI as a peace-building intervention means its production capacities are limited. As such, production within Fab Labs NI remains bespoke. However, the policy long game involves attempts to move away from the Fab Lab as community development apparatus, towards Fab Labs that perform a function in the national innovation system. In a white paper prepared for Belfast City Council, digital fabrication labs were proposed to be included in *Social Innovation Zones* as part of “mixed innovation districts” that aimed to regenerate “spatially disconnected communities” (Murtagh 2015, 3). This document drew on examples from the Basque Country, where evidence suggests that social economy clustering is viable and “has the potential to scale up to create meaningful economies” (Murtagh 2015, 3).

Makerspaces in Northern Ireland reveal a specific view of maker culture as they are situated in relation to a sectarian conflict that fuels ongoing tensions around national and local identity. Beyond this, they are charged with creating hope and opportunities for those affected by tensions on the ground. In practice, Fab Labs NI carry out discrete projects, shaped heavily by institutions, so they may contribute to the “new Northern Ireland” imaginary. These realities depart from the idea of the normative makerspace, that promotes peer production as a counter to industrial-scale economics.

SHENZHEN OPEN INNOVATION LAB (SZOIL), CHINA

Institutional arrangements

Shenzhen Open Innovation Lab (SZOIL) is a physical space and an online network that links actors in the maker culture ecosystem. It has four major

functions: research and development, innovation and entrepreneurial education, community development, and the development of maker supply chains (it specifically promotes itself as a conduit between the mass production ecosystems of Shenzhen and small hardware start-ups). SZOIL emerged out of complex state, industry, and local interests in makerspaces and maker culture, and is the first makerspace in Shenzhen to be affiliated with the global Fab Lab network supported by MIT’s Center for Bits and Atoms. It has been endorsed by the Fab Lab network as a research and development partner of Fab Lab 2.0, an initiative that prioritises manufacturing machines of the future.

At the primary level, SZOIL is a joint venture between Shenzhen Industry Design Association (SIDA)—a government body representing local industry development agendas—and Maker Collider—a platform offering products and resources to the maker community^[5]. These industry associations locate and negotiate development opportunities with commercial operators in areas with strategic importance to government. In Shenzhen, SIDA is very influential in a range of real estate projects driven by local policies aimed at promoting local creative industries, specifically those related to maker industries. SZOIL is located in the Sino-Finnish Design Park within the Futian Free Trade Zone, a local government initiative that promotes the clustering of high technology firms with closely affiliation to SIDA. The Sino-Finnish Design Park is one of many creative clusters that have emerged within the Futian Free Trade Zone since 2015. Director of SIDA, Shirley Feng, is a co-founder of SZOIL and a key promoter of Shenzhen as a ‘City of Makers’ and as a UNESCO ‘City of Design’. However, SZOIL’s affiliation with the Taikong Maker Alliance, places SZOIL in the heart of Chinese innovation policy by linking it to the country’s space and military program.

Co-founder of SZOIL and Maker Collider (and other maker-related initiatives in China) David Li, has become the face of China’s maker industries through his advocacy work in aligning the concept of

open source hardware development with Chinese Shanzhai[6] culture. However, Li openly opposes the open source movement's aspiration to maintain egalitarianism. In contrast, the mantra at SZOIL is 'not everyone can do it'. According to Li, "everyone has creativity in them but not everyone can take their ideas to the next level". Here he alludes to the reality that the "next level" is a complex mix of combination of knowledge, networks, empowerment, action, and capital.

Our study situates intermediary commercial corporations as secondary influencers of SZOIL. These organisations link makers to venture capitalists, global Internet of Things (IoT) platforms such as Amazon, and agile manufacturing plants located in China. Commercial corporations occupy an important position in SZOIL's organisation through their control of upstream and downstream services that are essential for makers. SZOIL provides services for makers to attract funding, acquire engineering solutions, develop design specifications and procure manufacturing contracts. These networks connect makers to over 150,000 industrial designers and 5000 agile manufacturing factories located in Shenzhen. In this context, processes of 'making' are an enabler of the potentialities of associated products and business opportunities.

While many maker projects develop in the context of loose organisational control, entrepreneurial development processes at SZOIL are highly coordinated to maximise economic outcomes for makers. At the secondary level, various local and international institutions offer the promise of streamlining services. The global crowdfunding service Indiegogo, Rone Phoenix Nest (Shenzhen), and electronics firm CYM provide supply chain services to global makers. US based think tank The Institute for the Future (ITFF) and New York University's Hacked Matter are key research partners linking SZOIL with international brands while contributing to its international prestige. The British Council's 'Hello Shenzhen'[7] initiative and the Thingscon network in Europe have both run joint

programs through SZOIL. While WIRED's video promoting Shenzhen as 'The Silicon Valley of Hardware' has raised the profile of the region internationally by situating it as a 'Future City.'

Significant peripheral influencers include state media organisations such as CCTV and the Xinhua News Agency. They endorse makerspaces as a nationwide mass innovation and entrepreneurship model central to the development of China's Cultural and Creative Industries. This momentum is linked to China's 13th Five Year Plan, that saw maker industries included as a key sector in transforming China's manufacturing future.

Maker culture and the re-imagining of a post-industrial city

Despite aggressive promotion of grassroots entrepreneurialism, Shenzhen maker industries have emerged from a top-down campaign to attract external investment. As such, makerspaces are an overt part of government-led urban regeneration strategies that aim to dramatically change the image of Shenzhen. These initiatives occurred in the wake of successful creative city promotions in Shanghai. Shenzhen developed tax free zones for technology industries and funded new makerspaces in creative clusters which urged commercial corporations to invest, or take part in extending the value chain of maker industries. The city also developed new entrepreneurship programs attached to maker industries. Emergent industries attached to digital making also embody a sense of fun and novelty, an appropriate match for a city searching for a post-industrial look. Leveraging the cultural capital of maker culture in the development of new urban imaginaries has successfully masked Shenzhen's socio-economic problems with the rhetoric of progress and solutionism.

Shenzhen has been sponsoring the global Maker Faire since 2010, and in 2015, the mayor declared Shenzhen the world's first 'city of makers'. In 2012, Shenzhen also became a UNESCO city of Design which helped promote its status as having the

highest IP rights per head in the world, which marked a significant shift in external perceptions of Shenzhen. Shenzhen has drawn inspiration from 'media cities' and 'creative cities' policies and schemes elsewhere in the world: the former placing emphasis on the production and distribution of 'symbolic goods' which place high value on originality, innovation, and creativity (Hesmondhalgh 2013); while the latter emphasises using large-scale flagship cultural institutions to improve the image and identity of a city, and to enhance the built environment for commercial, cultural, and recreational purposes (Landry and Bianchini 1995). These are key attractions to policy makers in China (O'Connor and Gu 2006). In addition, media cities serve either as nodal points in the global networks of cities (for example, Hong Kong as the gateway to Asia) (Hoyler and Watson 2013) or as global innovation hubs (for example, Silicon Valley) (Saxenian 1996).

Unlike Shanghai, the displacement of existing communities due to cluster development and gentrification—in urban villages such as *Baishizhou* that offered cheap accommodation to factory workers—has not been widely contested (O'Connor and Gu 2012, Gu 2014). Furthermore, the idea that putting makerspaces in creative clusters would attract people (and sell properties) has firmly taken hold in Shenzhen. The city currently has over twenty creative clusters oriented towards attracting makers and adjacent industries. 'Maker' as a term has become a powerful motif in the branding of inner city properties, and makerspaces are situated as amenity infrastructure.

Our investigation has also revealed that media conglomerates Tencent and Baidu have opened makerspaces in order to be part of an elite policy making network. Despite a lack of robust business models and best practices, these companies are supporting makerspaces as a form of speculative investment. These corporate-backed makerspaces, and the promises of innovation attached to maker industries, has influenced the projection that China will become a world leader in the IoT and Artificial

Intelligence (AI) by 2030 (Mozur 2017). This is also supported by reports situating China as the biggest investor in hardware start-ups globally[8].

The departure of mass manufacturing industries in Shenzhen have contributed to falling employment and tax revenues. This provides context as to why the remaining industries, local government, and local residents invest so much hope in maker industries. The hegemonic image of Shenzhen as a mass manufacturing city has been replaced by an equally hegemonic vision of the city of makers within less than ten years. Makerspaces, like the flagship cultural projects in other creative cities, carry particular symbolic and cultural importance to Shenzhen.

Although the evidence situates makerspaces as part of a national policy directive, they are emerging as a rare form of a 'shared space' in Shenzhen where politics, economics, and civics collide. The spirit of Shanzhai helps build common ground between individuals, commercial interests, and the state, underscored by antipathy towards the control and domination of global technology corporations. Maker culture in China has contributed to a transformative narrative: from manufacturing as low skilled, low value added, dirty and labour intensive to high tech, highly skilled, 'clean' and high value added. This has presented new opportunities for China, while offering context to its status as the 2nd largest economy in the world. However, complex socio-political agendas and the need to transform traditional manufacturing industries in Shenzhen has absorbed makerspaces like SZOIL and created new forms of hierarchies.

CONCLUSION

This study has shown how the established urban ideologies that drive unique institutional practices can significantly shape makerspaces. Evidence has strongly suggested that identity politics in China and Northern Ireland—underpinned by shifting socio-economic status—has provided much of the policy momentum for makerspaces. In China, we see the

performance of a new design-led and high-tech identity to accompany its increasing global soft power; and in Northern Ireland, a fledgling identity is emerging that emphasises skills in the development of innovative social technology.

Maker culture in our case studies does not display the traits of typical open source culture. Individuals involved in the makerspaces are organised under shared visions of new urban imaginaries, prescribed through policy. Furthermore, investment in makerspaces are heavily influenced by the state and the civil societies that they are embedded in. In both our cases, makerspaces are part of the reconstruction of urban images through innovation and creativity. Our research has revealed high level government attempts to reconstruct cities by leveraging the ‘hope’ attached to ‘innovative’ maker cultures. Here, makerspaces are used to rewrite the meaning of the city and replace negative urban images—of dirty manufacturing or disruptive civil conflict—with a positive vision of the future. The development of makerspaces is an attempt to reposition the two cities in the global circuit of media and creative industries.

We also examined the symbolic significance of makerspaces as an embodiment of a grassroots ethos. Initially seen as an industry of the past, Shanzhai manufacturing became central to Shenzhen’s attempts to reinvent its identity. This has contributed to the emergent urban ideology that makerspaces and maker culture will transform Shenzhen into a futuristic city. While in Northern Ireland, ongoing social cohesion efforts were rebranded as opportunities for digital social innovation. We also discussed the conscious attempts by local governments and commercial corporations to position makerspaces as essential inner city cultural amenities. Shenzhen, in particular, has aggressively marketed makerspaces to the likes of real estate developers. This evidence suggests makerspaces represent an elite vision of urban cultures, and that the pursuit of the makerspace as civic institution inviting widespread participation, has been marginalised.

Whilst the paradigm of maker cultures derived from ‘commons-based peer production’ has been consciously preserved and marketed by policy makers in both countries, they present very different realities aligning closely with civic boosterism and urban renewal. As such, the current momentum could very easily stall due to shifting political sands. In Northern Ireland, there is a question mark regarding ongoing support for Fab Labs NI from the EU in the post-Brexit climate. In China, if government forces shift policies (and money) away from the makerspace project, it is difficult to say where they will raise funds for ongoing operations. China’s increasing alignment with international common laws could also have a lasting effect on IP infringement.

The new urban imaginaries constructed with the help of makerspaces, represent a partial view of urban cultural policy. Each makerspace has different implications for industry sectors and local communities. In Shenzhen, there is very little mention of the workers made redundant due to the de-industrialization process or those left behind by the maker led property boom. While in Belfast, sectarian civil disruption and economic marginalisation are ongoing within many communities.

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NOTES

[1] For more information about the Made in China 2025 policy initiative, see <http://english.gov.cn/2016special/madeinchina2025/>

[2] For more information about the Mondragon Team Academy, see <http://mondragonteamacademy.com/>

[3] Northern Ireland has received significant economic stimulus from the UK and EU governments since the Good Friday Agreement in 1995. The country is currently moving towards a more independent economic foundation as peace-building initiatives offering financial subsidies are being wound down.

[4] For more information about PeaceTech Lab see, <https://www.youtube.com/watch?v=SBknWcDBndI>

[5] “About Us, SZOIL” <http://szoil.org/wp/#About>

[6] The literal translation of ‘shanzhai’ is ‘mountain fortress’ and it designates to a group of outlaw entrepreneurs who operate outside of the authoritarian control of economic and cultural production.

[7] For more information about the Hello Shenzhen initiative, see <https://creativeconomy.britishcouncil.org/projects/hello-shenzhen/>

[8] “Why Crowdfunding Is Still Booming, Especially For Chinese Tech Companies”

<https://www.forbes.com/sites/benjaminjoffe/2017/07/18/crowdfundings-death-has-been-greatly-exaggerated-creators-ship-especially-in-china/#31cf7d082c40>

REFERENCES

Alper, M 2013, ‘Making space in the makerspace: Building a mixed-ability maker culture’, In *Interaction Design and Children*. June 24–27, New York, NY.

Anderson, C 2012, *Makers: The new industrial revolution*. New York: Crown Business.

Ashton Community Trust annual report 2012-2013.

Ashton Community Trust constitution 2005.

Benkler, Y 2002, ‘Coase’s Penguin, or Linux and the Nature of the Firm’, *The Yale Law Journal*, vol. 112 no. 3.

Benkler, Y 2006, *The wealth of networks: How social production transforms markets and freedom*. New Haven and London: Yale University Press.

Carstensen, T 2013, ‘Gendered Fab Labs?’ In *Fab Lab: Of machines, makers, and inventors*, Walter-Hermann, J & C Buching eds Bielefeld: Transcript Verlag.

Chubb, A 2015, ‘China’s Shanzhai Culture: Grabism and the politics of hybridity’, *Journal of Contemporary China*, vol. 24 no. 92 pp. 260-279.

Driscoll, K 2012, ‘The Dark Side of DIY—Makerspaces and the Long, Weird History of DIY Hobbyists & Military Funding’, <http://civicpaths.uscannenberg.org/the-dark-side-of-diy-makerspaces-and-the-long-weird-history-of-diy-hobbyists-military-funding/> [accessed June 24, 2017].

Fab Lab Feasibility Study 2016, Fab Foundation Ireland and Creative Spark.

Gershenfeld, N 2005, *FAB: The coming revolution on your desktop. From personal computers to personal fabrication*. Cambridge, Mass: Basic Books.

Greenspan, A 2014, *Shanghai Future: modernity remade*. London: Hurst & Company.

Gu, X 2014, ‘Creative Industries, Creative Clusters and Cultural Policy in Shanghai’, In *Cultural Policies in East Asia: Dynamics between the State, Arts and Creative Industries*. Lim, L and Hye-Kyung L (eds) London: Palgrave Macmillan.

Gu, X In press, ‘The paradox of Maker Movement in China. In *Making our world: The hacker and maker movements in context*. J Hunsinger and AJ Schrock (eds). New York: Peter Lang.

Hammersley, M & Atkinson, P 1995, ‘Ethnography:

- Principles in practice', *Contemporary Sociology*, vol. 10 no. 4.
- Hesmondhalgh, D 2007, *The Cultural Industries* (2nd edition). London: Sage.
- Hoyler, M & Watson, A 2013, 'Global media cities in transnational media networks', *Journal of Economic and Social Geography*, vol 104 pp. 90–108.
- Hunsinger, J, & Schrock, A. J 2016, 'The democratization of hacking and making', *New Media & Society* vol. 18 no. 4 pp. 535–38.
- Kostakis, V, Niaros, V, & C Giotitsas 2015, 'Production and governance in hackerspaces: A manifestation of commons-based peer production in the physical realm?' *International Journal of Cultural Studies*, vol. 18 pp. 555–73.
- Kohtala, C 2017, 'Making "making" critical: How sustainability is constituted in Fab Lab ideology', *The Design Journal*, vol. 20 no. 3.
- Landry, C, & F. Bianchini 1995, *The creative city*. London: Demos.
- Lindtner, S 2015, 'Hacking with Chinese characteristics: the promises of the maker movement against China's manufacturing culture', *Science, Technology & Human Values* vol. 40 no. 5 pp. 854–79.
- Maxigas & P. Troxler 2014, Editorial. *Journal of Peer Production*, no. 5.
- <http://peerproduction.net/issues/issue-5-shared-machine-shops/>
- Moilanen, J, Daly, A, Lobato, R, & Allen, D 2015, 'Cultures of sharing in 3D printing: What can we learn from the licence choices of Thingiverse users?' *Journal of Peer Production*, no. 6.
- Mozur, P 2017, 'Beijing wants A.I. to be made in China by 2030. *The New York Times*, July 20, 2017, <https://www.nytimes.com/2017/07/20/business/china-artificial-intelligence.html?mcubz=3>, [accessed July 1, 2017].
- Murray, PR & Hand, C 2015, 'Making culture: Locating the digital humanities in India', *Visible Language*, vol. 49 no. 3.
- Murtagh, B 2011, 'Desegregation and Place Structuring in the New Belfast', *Urban Studies*, vol. 48 no. 6 pp. 1119–1135.
- Murtagh, B 2015, 'Reconnecting the city. Concept paper for Belfast City Council. *European Commission Innovative Urban Actions*.
- Nerve Centre annual report 2012.
- Northern Ireland Multiple Deprivation Measure 2010. Northern Ireland Statistics and Research Agency.
- Northern Ireland Multiple Deprivation Measure 2017. Northern Ireland Statistics and Research Agency.
- O'Connor, J & Gu, X 2006, 'A New Modernity? The Arrival of 'Creative Industries' in China. *International Journal of Cultural Studies*, vol. 9 no. 3 pp. 271–283.
- O'Connor, J & Gu, X 2012, 'Creative Industry Clusters in Shanghai: A Success Story?' *International Journal of Cultural Policy*, vol. 20 no. 1.
- Ramsey, P 2012, 'A pleasingly blank canvas: Urban regeneration in Northern Ireland and the case of Titanic Quarter', *Space and Polity*, vol. 17 no. 2 pp. 164–179.
- Richmond, OP & Mitchell, A 2011, 'Peacebuilding and critical forms of agency: From resistance to subsistence', *Alternatives: Global, Local, Political*, vol. 36 no. 4 pp. 326–344.
- Saxenian, A 1996, 'Inside-Out: Regional networks and industrial adaptation in Silicon Valley and Route 128', *Cityscape: A Journal of Policy Development and Research*, vol. 2 no. 2 pp. 41–60.
- Scholz, T 2013, 'Introduction', In *Digital labor: The internet as playground and factory*. T Scholz (ed) New York, NY: Routledge.

Shea, P 2015, 'DIY Citizenship in the 'New Northern Ireland': The Case of a Belfast Makerspace', In *Civic Media Project*, E Gordon and P Milhadis (eds). An Initiative of the Engagement Lab at Emerson College and MIT Press.

Shea, P 2016, 'Civic practices, design, and makerspaces', In *Rethinking digital citizenship: Control, contest, and culture*. A McCosker, S Vivienne and A Johns (eds). London: Rowman and Littlefield.

Shea, P In press, 'Hacker agency and the Raspberry Pi: Informal education and social innovation in a Belfast makerspace', In *Making our world: The hacker and maker movements in context*. J Hunsinger and AJ Schrock (eds) New York: Peter Lang.

Smith, A 2014, Technology Networks for socially useful production. *Journal of Peer Production*, no. 5.

Smith, A & Light, A 2017, 'Cultivating sustainable developments with makerspaces', *Liinc em revista*, vol. 13 no. 1 pp. 162-174.

Toupin, S 2014 'Feminist hackerspaces: The synthesis of feminist and hacker cultures', *Journal of Peer Production*, no. 5.

Troxler, P 2013, 'Making the third industrial revolution—the struggle for polycentric structures

and a new peer-production commons in the Fab lab community', In *Fab Lab: Of machines, makers, and inventors*. J Walter-Hermann & C Buching eds Bielefeld: Transcript Verlag.

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THE SOCIOMATERIALITY OF FABLABS: CONFIGURATIONS OF A PRINTING SERVICE OR COUNTER-CONTEXT?

Cindy Kohtala

FabLabs can be studied as a technology- and product-oriented movement. In this study, I review material objects in European FabLabs as sociomateriality that represents and embodies the ways FabLabs are institutionalising. This refers to FabLabs' relationships with incumbent institutions and how they impact the formation of norms and routines internally. Labs may adopt procedures familiar in mainstream organisations, borrowing from formal institutions in a quest for public inclusion and mainstream legitimacy, or they may seek to innovate in organisational structure, establishing themselves as informal institutions to maintain their counter-culture identity. Examining sociomateriality helps make visible how Labs manage the contradiction between 'openness' and recruitment of allies, and maintaining alterity. The studied FabLabs' institutionalising processes are ongoing, performative and heterogeneous, encompassing mixed tactics oriented towards both public inclusion (commodification and conforming) and counter-culture (reconstitution and transforming). We also propose that analysis conducted through three types of objects, work, knowledge and imaginative objects, provides a more articulated account of the tensions in material peer production.

Keywords: FabLabs, sociomateriality, sustainability, institutionalising, STS, ethnography

by Cindy Kohtala

INTRODUCTION

As sites for research, shared community spaces for digital fabrication offer insight into how (or if) citizens engage in material production and with fabrication technologies. They reveal how people shape peer-to-peer communities and what future impacts, social, economic or environmental, these spaces and practices may entail. The MIT FabLab network is a type of makerspace community that grew from an outreach project by MIT's Center for Bits and Atoms (CBA) in the early 2000s. FabLabs around the world are free to establish their own spaces, activities and networks, but they also share an identity and are encouraged to have some common working practices in order to foster inter-lab collaboration (Gershenfeld 2005). A shifting dynamic involving network identity, lab autonomy, regional collaboration, bottom-up agency and top-

down governance, renders the network a fascinating subject of study, particularly given its rapid growth, diversity of operating environments and range of lab ages. The oldest labs may be seen to have established routines while the youngest have yet to establish their norms and conventions – and in practice this institutionalising process is in constant change.

As a network entity, FabLabs promote their role in expediting the 'new industrial revolution', marked by citizen participation in all forms of socially useful production and the 'democratisation' of production technologies. In enacting these visions, some labs innovate in ways to collaborate while others adopt routines of business-as-usual. In their successful branding and the global spread of their particular type of 'maker culture', FabLabs have been accused of maintaining the values and structures of the current economic system and thereby merely reproducing capitalist ills. Simultaneously FabLabs aim to be open-access community workshops, and

attracting and retaining users necessitates procedures that are at least somewhat familiar to a wider audience.

The FabLab global network comprises a logo and charter, online and offline collaboration, participation in the worldwide educational undertaking the Fab Academy, international and regional meetings, and responsibility for much sponsorship and global communications being managed by one body, the Fab Foundation. Nevertheless as individual entities FabLabs are also diverse, local and situated. They are actual spaces – rooms, buildings, offices, former factories – peopled by actual bodies; filled with actual, tangible materials; surrounded by neighbours and built upon particular local histories. Lab managers must carry out their own strategy work, earn income and target desired users. Equipment may be chosen according to identified local needs, or the equipment selected may then shape who enters and who stays. Projects may be promoted as valuable by managers or users, while other projects remain unfinished, unremarked and unseen. Technologies become invisible as infrastructure or tools remain broken and unmaintained.

Things *are* produced in FabLabs, so of course things are important. But it is instructive to bear in mind how the social and the material are intertwined. Does the thing become a ‘story’ – a symbol of success and material realisation of a certain vision? Is one object – an open-source 3D-printer – favoured explicitly over another – a proprietary printer? How does an object constrain the group and what they want to achieve? What work-arounds do they adopt to counter this? How each lab goes about its business, each decision and configuration, constructs many micro-trajectories. Some procedures become routines and experiments become practices; other aims sit on to-do lists and continually reappear in various tactical forms. Objects make visible these trajectories of how the lab is institutionalising: how relations with other, more formal institutions – the mainstream, incumbent entities with whom the lab collaborates

or competes – shape the norms, procedures, operating systems and values the lab adopts.

Some labs are staunchly committed to open software and hardware, for instance, and this commitment is visible in their sociomaterial arrangements such as the tools they use to organise assemblies. Some labs emphasise transformation to a more ‘sustainable’ and participative society; examining objects in these labs can help identify how they keep both discourse and activities concerning environmentalism and social justice in play. The current diversity of labs therefore offers some idea as to what pathways are possible: the types of ‘innovation’ various labs foster indicate the forms these shared machine shops may take as they settle in and out of alignments.

With this in mind, I set out to observe a group of European FabLabs, to begin to understand some of the range of people, practices and places. This study reflects upon this research material to explore the tensions in establishing norms and routines. How do FabLabs react to the dominant sociotechnical culture in which they operate? To what cultures and practices do they align and what do they wish to redress? How do material objects reveal these processes? The following sections will elaborate upon the theoretical understandings of sociomateriality and institutionalising relevant to this study, as well as the research gaps addressed. The fourth section describes the research material and study methods. The key themes of FabLab objects are then discussed, followed by conclusions.

INSTITUTIONALISING IN TECHNOLOGY MOVEMENTS

In discourse, the FabLab mission is to bring groups the *means* to make their own technologies locally, rather than the technologies themselves (Gershenfeld 2012). But FabLabs court controversy in their day-to-day activities by appearing to be catering to a myriad of objectives and partnering with a range of bedfellows. Commercialising is often ‘construed as a sensible means for sustaining the

activity (and livelihoods)' for some, while signalling 'disappointing co-option' for others (Smith et al. 2017, p. 122). Hess's (2005) concept of technology- and product-oriented movements well captures this phenomenon. Technology- and product-oriented movements are 'mobilizations of civil society organizations that generally are also linked to the activity of private-sector firms, for which the target of social change is support for an alternative technology and/or product' (Hess 2005, p. 516). Since these alternative technologies can be linked to a wider agenda such as lifestyle change, there are advantages to examining their creators as 'mobilized publics' in social-movement theoretical frames, as well as Science and Technology Studies (STS) (Hess 2016). Some technology movements utilise 'alternative institution building as means for change' and some become incorporated, thereby diluting the original social movement goals (Hess 2005, pp. 517-18; 2016).

Hess (2016) draws on the framework of 'institutional logics' from institutional theory (Friedland and Alford 1991) in his analysis, meaning that each institution has its own 'set of material practices and symbolic constructions' (Friedland and Alford 1991, p. 248). To study industrial transitions is to study the conflicts and changes in institutional logics when social movements challenge incumbents: that is, when different systems of meaning – systems of design, systems of ideology – meet (Hess 2016, pp. 17, 146-150). In simplified terms (and incorporating the perspective of Transition Studies), these alternative systems either 'fit and conform' to incumbent institutions (in regimes) or serve to 'stretch and transform' them (Smith and Raven 2012; Dickel et al. 2014). (For reasons of simplicity, in this study incumbent organisations in dominant regimes will be referred to as formal institutions and FabLabs, as challengers, termed informal institutions, even though it is recognised some FabLabs register themselves formally as associations, cooperatives or companies.) In practice, when incumbents and challengers meet, various syntheses and combinations occur (Hess 2016, pp. 146-150), and both the logics and their

interactions are seen as ambiguous, inconsistent and open to interpretation (Pfaffenberger 1992, p. 297). What is most relevant in this study is examining the meeting of different logics (design and ideological systems), how they impact the formation of accepted norms and procedures in a FabLab (i.e. how it institutionalises), and how this is visible in sociomaterial terms.

These processes can be illustrated by imagining two extreme FabLabs. The first lab is the most visitor friendly, we could call it Peer Production as a Service (PPaaS). The lab is well branded and organised. Instructions to both the use of the lab and use of individual machines are easily found. Displays of projects show what can be done and with what techniques. Tutorials and information relevant to users are organised and accessible. Back-office activities such as the lab manager's own task list or strategic priorities are likely to be less visible, deemed less relevant to visitors. Such an office may be physically tucked away elsewhere, away from the main working and social space. The fabrication service stops at making the artefact for the visitor.

At the other extreme we have a lab that is the least accessible to first-time visitors, rather like a community space by insiders for insiders (see Wu, Whalen and Koskinen 2015, for an example of such an 'anarchist' workshop). Instructions are not forthcoming. Tools, equipment, materials and components may appear to have their own system of organisation not apparent to the visitor. Objects the community uses to organise itself, from meeting agendas to maintenance logs, are visible and accessible, even if not necessarily understandable. There are no clear differentiations between spatial functions: office and management, working and experimenting, socialising and playing. First-time visitors enter and do not know what to do or even who to ask for further guidance.

In these hypothetical examples, the first lab is oriented to the incumbent institutional logics of familiar printing services and has configured aspects of its infrastructure and artefacts accordingly. Its

norms and routines fit and conform to formal institutions in an effort to maximise users' ease and convenience: taming the wildness of the otherwise rebellious technologies and revolutionary access to them, in order to accommodate a wider public. The second lab, in contrast, confronts incumbent institutional logics by *prefiguring*: establishing a counter-culture space, a 'counter-context' (Pfaffenberger 1992) in which both technologies and behaviours are actively reshaped. Alternative beliefs and procedures are put into practice, in an alternative institutionalising process to redress the perceived dominance of a capitalist, consumerist system and render it symbolically (and materially) obsolete. Pfaffenberger (1992) has called such self-conscious reshaping of technological processes and artefacts 'reconstitution', and in this study reconstitution is seen in direct opposition to processes of commercialising and commodifying.

Obviously these dynamics continue, with incumbents challenging reconstitution efforts (at times resulting in co-option) and informal institutions settling into routines that still others resist. In the FabLab network, individual labs and regional networks also establish their *own* procedures as explicit acts of deviance from FabLab network norms (Troxler 2014; Neale and Hobern 2017), which in turn were established as acts of deviance from dominant corporate technology development and mass production logics. This double manoeuvre, a re-reconstitution, evidences the ongoing-ness and dynamic nature of institutionalising processes.

Useful as Hess's and Pfaffenberger's concepts are for understanding the role of challengers to industrial incumbents in sociotechnical change, the analyses remain mainly at a macro level that loses the granularity of how organisations like FabLabs negotiate their sociomaterial practices from day to day. Insights into how labs attempt to enact 'revolution' at a material level – the challenges they face and tactics they adopt in doing so – are helpful if we are to understand these shared machine shops' potential to transform consumer capitalism.

SOCIOMATERIALITY

Focusing on materiality in DIY maker culture tends to aggrandise solutions, resulting in a mere cataloguing of projects. To counter this, critical academic studies have examined, for instance, material attachment and sustainability implications in makerspaces (Maldini 2016), questions of identity as mediated through materials (e.g. Toombs, Bardzell and Bardzell 2014) and the more interventional Critical Making line of inquiry (Ratto 2011). Whether studies explicitly use the term 'sociomaterial' or not, they generally acknowledge the bundling, entanglement (Barad 2003) or assemblage (Law 2004) of the social and material.

However, relatively few studies on DIY making thus far have examined materiality to deliver insights into how community workshops arrange themselves as collective enterprises. This dearth contrasts with the legacy of STS scholarship that has addressed the relationality between the human and non-human in collaborative work. Sites of STS studies have included, most famously, scientific laboratories and software development organisations, but also architecture offices, energy retrofitting projects, activists' repair workshops and others (e.g. Suchman 1987; Orlikowski 2000; Büscher et al. 2001; Latour 2005; Callén and Sánchez Criado 2015; Buser and Carlsson 2017). In turn, relatively few STS studies on collaborative work and institutionalising have examined social movements and informal collectives. FabLabs are not science laboratories, workplaces nor home (Kohtala and Bosqué 2014), and the work is neither job nor hobby but somehow both (Menichinelli et al. 2017). The *symbolic* role of objects is therefore arguably even more important in examining FabLabs, in how they represent objectives and recruit and galvanise participants (Pfaffenberger 1992; Hess 2016, p. 167).

The conceptualisation of 'objects' in the STS analytical framework Symbolic Interactionism (Blumer 1969) understands them as both materials and concepts, and it is helpful in retaining the epistemologically important entanglement of the

material and discursive. Symbolic Interactionist studies examine how collective discourse and action unfold in interaction. FabLabs are seen as part of a social world (Strauss 1978) that interacts with other social worlds such as incumbent institutional logics; subworlds shift 'as patterns of commitment alter, reorganize, and realign' (Clarke and Star 2008, p. 119). The materiality of DIY making renders visible how social worlds of production elide and collide. Our technical environments are clearly not seamless; to the contrary they are messy and *seamful* (Chalmers and Galani 2004; Vertesi 2014). Objects 'allow' people into alternative acts, inventive bricolage and production of disobedient counter-objects as much as they shepherd them into familiar conventions. The work of putting messy, disparate systems – of design, technology and culture – to work together, elicits possibilities to question and transform, or repeat and freeze routines. How FabLab collectives attempt to order a seamful mess thereby signals how they institutionalise.

The next question is then whether the spaces, activities and objects of FabLabs can or should be analysed as work (Berg 1997); as knowledge creating assemblages as in science laboratories (Latour and Woolgar 1986 [1979]); as citizen-science social movements producing alternative knowledges (Papadopoulos 2015), or 'unruly publics' attempting to change policy or behaviour (de Saille 2015); or if all these frames can be kept in play simultaneously. FabLab objects are about organising work, but they are also about exploration and building knowledge. As a technology movement, FabLabs create symbols and use imagination, play and ritual in constructing ideological discourses that muster and mobilise. But what happens at the seams? What do objects anchor: what systems, worlds, logics and possible futures?

In subsequent sections, we will examine further the concepts of work objects, knowledge objects and symbolic, imaginative objects, with examples from my empirical data to illustrate. Before this discussion, a clarification of the research sites

follows below.

THE RESEARCH SITES

FabLabs are useful sites for a study on materiality, as they are encouraged to procure the same inventory. Many labs participate in the network's own online and offline training programme Fab Academy, which further encourages sharing ideas on processes and practices.

This study comprises data gathered in thirteen European FabLabs. One lab was the target of a longitudinal ethnographic study examining how environmental sustainability was represented (Kohtala 2017). The field studies in the other twelve sites were conducted to understand the range of labs (who hosts, who funds and who visits) and objectives. Attention was paid to and notes were made on equipment, displays, documents, projects and lab layouts, as well as what managers and users themselves highlighted. Digital artefacts such as booking systems on websites are also material, as people access them with their bodies via physical interfaces such as keyboards and screens; such objects were noted when they were used and actors explicitly discussed their development. Because of the more general objectives at the time, details on objects were not systematically recorded for purposes of strict cross-comparison. This analysis thus relies on data gathered at the time. The data nevertheless consist of extensive fieldnotes backed with audio and video recordings and substantial photo documentation (see Table 1, Appendix 1). Such analysis must acknowledge the subjective attention of the researcher and what may have gone unrecorded and unnoticed, but it also garners strength from observations sensitised to design and materiality due to my design background.

Two labs in the study were initiated with European Commission project funds, and one lab's initial equipment procurement was funded by the Fab Foundation, in the first round of FabLabs established outside the US in the early 2000s. Six labs were founded by private individuals, as entrepreneurs, as

people in the creative sector needing a workspace and willing to offer a shared facility, and as a private experimental space. Two labs are funded by universities and one by an arts association. One is hosted by a municipality and two labs by professional industry associations. The labs are also notably art and design 'heavy', meaning they are located in design and architecture schools, run by professional designers and artists or have the local design council or association as a founding member (nine of the thirteen). The other labs have engineers or technology analysts as founders or a technology- and product-development association as host (four of the thirteen). All labs bar one are in cities; one of the city labs is in a peri-urban area of a large city. (See Appendix 1.)

Beyond this dataset, ethnographic observations have continued in the main FabLab site and visits have been made to fifteen other FabLabs, hacklabs and makerspaces, including sites outside Europe. Participant- and non-participant observations have been made at three international FabLab meetings and during Fab Academy implementation, as well as during community events held in the Helsinki DIY maker scene. Key impressions from this fieldwork have therefore also informed this analysis.

For this study, identifying the role of objects was a primary task. The three categories of objects derived from examination of STS theoretical discussion on objects, reflected against other empirical studies on FabLabs and makerspaces as well as my own research material. In thematic analysis, the notes, transcripts and photos in the dataset were examined with these guiding questions: what objects appear in all or most labs and what objects are particular to some labs? What do participants highlight to the researcher and make visible to others; what issues may be rendered invisible? From the perspective of norms and routines, what do the objects represent in terms of collaboration and communication? Examples from the data were selected that best illustrated the three types of objects, and the institutionalising dynamics made visible by the objects were

articulated in narrative memos. The following sections will elaborate on the study's key insights.

ON OBJECTS

The concept of *work objects* (Casper 1998) is helpful in drawing attention to how social order is negotiated to get things done. Things make work visible, whether they are to-do lists on a whiteboard, unconference agenda posters for participatory organising, or hacks and work-arounds. Work objects also point to how different technical worlds come together, such as when things-and-practices from a computer science educational culture meet things-and-practices from the manufacturing world.

Another important STS concept is *knowledge object* (Knorr Cetina 1997), and particularly in questions pertaining to sustainability, knowledge work is important. Citizen groups rally on topics of importance and fight to have their expertise recognised (Ottinger 2010). They build their knowledge experientially, with hands-on work, using their bodies and engaging with materials (Marres 2015). DIYbio labs and hackerspaces produce 'alternative ontologies' (Papadopolous 2015). The knowledge object therefore appears capable of bridging the concerns of STS and social movement studies, and we can employ it when examining FabLabs' pursuit of knowledge: both the present-oriented, practical exploration of how to localise production, and the future-oriented pursuit of how to shape commons-based peer-to-peer communities. Such objects thus embody both pragmatism, in local fixes, and utopianism, in visions of self-sufficient, ecologically conscious, convivial futures (cf. Sadler 2012).

This leads us to another type of object I argue is important in FabLabs but perhaps receives less attention in STS scholarship: the symbolic role objects can play in imagination, conveying a particular vision and animating actors. Objects such as the interface for event-organising software – where some functions can be automatised, allowing participants to take on the role of co-organisers –

help this group build knowledge on horizontal governance and values-in-design in interface choices (Flanagan, Howe and Nissenbaum 2008). But they also represent and legitimise, by partially realising, a particular vision where self-organising groups work to preserve a particular commons. These visions form part of the alternative institutional logics – the material practices and symbolic constructions – labs co-produce.

In considering the history of science, Wartofsky argued for the role of the ‘imaginative’ object: how ‘constructions of alternative imaginative perceptual modes, freed from the direct representation of ongoing forms of action, (...) feeds back into actual praxis, as a representation of possibilities which go beyond present actualities’ (Wartofsky 1979, p. 209). For Judith Gregory (2000), building on Wartofsky, utopian visions need not be realised to have resonance, and their very incompleteness is in fact propitious. ‘Incompleteness and heterogeneity are desirable because by their openness they provide opportunities for new and/or different actors, new elements which may be discontinuous from historical precedents, and alternatives that may be oppositional or engage resistance’ (Gregory 2000, pp. 101-102). Visions of alternative futures resist incumbent systems of meaning (such as consumer capitalism) and evoke new lifeways. Visions mobilise actors, particularly when they begin to emerge in material form – as resources for imagination: ‘The “impact” of technology begins when imagination and aspiration begin to be shaped by it, often long before any “working” technology exists’ (Hyysalo 2010, p. 251). We can thereby call these partial realisations in FabLabs *imaginative objects*.

There is nevertheless a flipside to how visions help shape group norms. Symbolic objects are used to keep a community unified and, in so doing, keep other people out. In other words, we should be aware of sociomaterial processes of boundary *spanning*, but also boundary *policing* (Ottinger 2010). What is especially important in FabLabs, because it is easily under-addressed, is the question

of intentionality: keeping people out is not only achieved through active and knowing boundary policing. Dynamics related to expertise and community identity can create unintended hierarchies in peer communities (Schor et al. 2016; Toombs 2016). Moreover, community building aligned with certain institutional logics can keep consequences (such as environmental impacts) invisible – outside the realm of the FabLab (Kohtala 2017). In this way, I see imaginative objects also acting as a *membrane* – strengthening the identity of the community inside, but (intentionally or unintentionally) keeping people, issues or impacts out.

FabLab communities do not represent a particular professional or scientific practice, hence imaginative objects will represent varying institutional logics, from those that orient more to an industrial world (such as machines-that-make-machines) to visions of a better world in socio-environmental terms (such as beehives or aquaponics projects). These heterogeneous visions appear likely to foster a splintering of the FabLab movement into various trajectories as it matures; analysing imaginative objects, alongside (or as hybrids of) work and knowledge objects, in peer production offers a more articulated account of the tensions involved in FabLab institutionalising and these possible trajectories.

ON WORK OBJECTS

When we look around a FabLab we see documents (order forms, instructions and manuals, project documentation, posters and manifestos, newspaper clippings, certificates); tools, machines and instruments; components and materials; and projects in various states of display and completeness. When the ethnographer is in a lab, tours involve tours of the equipment. When she shadows the participants, and when new actors are inducted into the lab, we learn how things are to be done. We regularly hear the phrases “this is how it is done in FabLabs”; “usually in FabLabs...”; “in FabLabs we...”. But FabLabs are not plug-and-play.

It is spring 2012. The lab I am in is in the process of being built, its workflows as well as walls to isolate the noisiest and dustiest machines. The two lab managers have been acquiring equipment, deciding on its placement in the lab and doing the necessary set-up and calibration work. Most of the equipment choices have followed CBA's inventory recommendations. Both managers have worked in FabLabs previously in other countries. The lab is not yet open for users, but a teacher from the Media department in the university brings his students in to get a demo of the machines. Getting the Modela milling machine running has been one of the managers' greatest challenges. The one manager has been able to do a test run, cutting the traces of a PCB (printed circuit board) successfully after many attempts. Now it is time to cut out the outline of the board using a different end-mill. It is an opportune moment to show the students how the machine works and how they can mill circuit boards instead of etching them using 'dangerous' materials, particularly if they need only one board.

Manager 1: "For using the Modela, (...) we need to use software that runs on Linux, so basically we will have a virtual machine. (...) You log into Mac and then it will start with Linux."

student: "What if the software is not available for OSX, is it just for Linux?"

Manager 1: "You can try to start on Mac but—"

Manager 2: "It doesn't work."

Manager 1: "Yeah, basically it doesn't work and no one has been able to access the server yet."

Manager 2: "And this is the software that MIT, the original FabLab, these are the tools that *they* have been using, so for the Modela we thought that would be the *best* way. Because we really had problems trying to get it running with Windows, to print the boards, and all kinds of things, that the driver software was not compatible with the new operating systems and so forth. Annoying. So we went with

Linux."

Manager 1: "And in any case if you want to talk with the other FabLabs to ask for help, they will explain to you how to use this software, everybody uses this."

The manager continues to show them how to insert the end-mill and set the zero point.

Manager 2: "One of the complications, we also had to get the US-sized milling bit holder for the thing, so the cable was wrong, and we didn't have the proper sized milling bit holder, so lots of things to prepare."

Manager 1 then shows how to operate the Fab Modules interface, for changing settings and sending the job to the machine.

Manager 1: "Sometimes it's a bit slow because we need to have these two cables to communicate with it, and there's a chip inside this, so these are the small tricks."

student: "Is that a serial port that connects with it, so USB to serial? Interesting trickery!"

Manager 1: "Yeah, when you see a machine that doesn't do what it is supposed to do, you understand there is something wrong."

Manager 2: "The Modela doesn't come with a USB port or anything else except a serial port, and then you have to find a computer that can hook up with it, or you have to run a cable that can deal with modern computers. So finding a computer that can run Windows XP and have a printer port, well, by now that's a bit difficult. So I went chasing after laptops of ten years ago, from the design department and a few other people. We're happier with this now. [slight pause] It works when it works."

By no means is this an unusual exchange; workplaces are seamful spaces (Vertesi 2014) full of multifarious technology standards and practice histories in a bricolage that reassembles itself with

each new project (Büscher et al. 2001). The example above shows well the articulation work that needs to be performed to achieve results, the ‘work done in real time to manage contingencies: work that gets things back on track in the face of the unexpected’ (Bowker and Star 1999, p. 310). While such articulation work is not unique to shared machine shops, it is notable that the FabLab network has designed and implemented its own solution for joining seams, Fab Modules: software for generating toolpaths and visualising workflow, spearheaded by founder Gershenfeld and CBA with self-selecting contributors from across the network. As a work object, it is innovative in a way easily unrecognised as product ‘innovations’ that capture media attention, the work of infrastructure repair and maintenance (Jarzabkowski and Pinch 2013). The software settles labs into FabLab network institutional logics and allows bricolage of diverse systems. But not all labs use the Fab Modules at all times, as the software itself – in aiming for ease and modularity – tends to black-box some settings and removes some amount of control that competent lab managers resist.

In norm forming, the history behind the “in FabLabs we...” phrase is rarely discussed, in my hearing. People, after all, come from varied backgrounds, and even people with an education in computer science or machine engineering will have different habits, preferences and terminology, depending on their background. At times lab managers or users become flummoxed at some of the Fab Academy procedures, as they would go about the task in a completely different way. Still, in FabLabs, the Fab Academy way often presides without being questioned. In Christina Dunbar-Hester’s (2014) study, a similar non-questioning of technical antecedents, a lack of awareness of the technical cultures at play in a media activist community, appeared to strengthen the narrative of a male-dominated technical culture – despite espousal of a desire to universalise and democratise technology. ‘Construing DIY to be the universalist antidote to hierarchical engineering culture was ironically reproducing some of the very problems the activists

sought to evade’ (p. 85).

Much of the FabLab model is put across as ‘design from nowhere’, akin to technical systems construed as ‘commodities that can be stabilized and cut loose from the sites of their production long enough to be exported *en masse* to the sites of their use’ (Suchman 2000, p. 5). FabLab actors know there is no stable model: there is much work to be done onsite to build the community of users, establish practices and workflows and develop strategies of action and identity. It appears there is little time to question or pursue the whys and wherefores of FabLab ways. However, it also appears that – in order to be inclusive – FabLabs need to *prefigure* some of their procedures, to counteract unquestioned (and often undetected) inheritances. Hierarchies of norms, routines and best practices from other technical cultures prevail throughout the network, despite espousal of democratic, nonhierarchical and non-technocratic procedures. Individual labs may resist these undiscussed hierarchies and will ‘re-constitute’ work objects such as the Fab Modules or even the Fab Academy to regain power locally and establish their own norms and routines.

ON KNOWLEDGE OBJECTS

The growth of innovation labs and living labs in the global North, including FabLabs, is seen as a signal of attachment to an ‘experimentalist culture’ (Leadbeater 2014). In FabLabs, activities and knowledge-building processes are geared to the expectation that a mix of people will spur invention and innovation through hands-on play and experimentation, but these expectations are constrained by what the equipment affords.

It is 2013. I am speaking to a university FabLab manager, one responsible for the electronics. He used to work in an electronics workshop in another part of the university, which he says has the same facilities. “Or maybe even more. Because we tried to keep it simpler [here] than the [other workshop], because we thought the artists might not need that

accuracy, or-. For example, in buying the oscilloscopes and meters and stuff, we didn't get the best ones, or not the most accurate ones-no, that's not a good word either." He smiles and hesitates. "What should I call it. For example we have an oscilloscope for 40 megahertz and for 60 megahertz and for 120 megahertz, and when you are doing some RF [radio frequency] things, then you use the 120 megahertz. But because no one is doing RF things here, there wasn't any need for that. I mean it like that, I don't know a good word for that."

I try to help: "The scale, or the-."

He replies, "Yeah, the specialised, or-, yeah. So we got everything based on the *need* we expected the people would require. And it has been sufficient so far."

Experiments in FabLabs are logged in an unsurprisingly diverse way. Experiments in DutchLab4, for instance, are oriented to citizen science and natural resource commons, and some of them are visibly marked in what could be called a scientific way to improve future experiments. Experiments with 3D-printing various materials in DutchLab5 are also catalogued and carefully documented. In contrast, experiments with the biodegradability of locally manufactured bioplastics in DutchLab6 were more oriented to proof-of-concept and community-building. In this case, the lab manager and a regular user first tested the bioplastic filament by printing the user's sculpture designs and then burying them in the back garden, digging them up from time to time to visually gauge the amount of degradation. This is the kind of object that bounds the concept of knowledge object and imaginative or symbolic object together, but it also signifies that these participants do not see the need for my earlier manager's named values of 'accuracy' or 'specialisation' – that is, incumbent institutional notions of legitimate knowledge – particularly if they are seen as instrumentalist and stemming from cognitive capitalism. What is important is rather the embodied participation in the process, its incompleteness and 'ongoing-ness' (Hobson 2016),

and the visibility of results. As also in DutchLab4, issues related to environmental sustainability and peer production are better understood when they are *experienced* and 'performative' (Corvellec 2016) – prototyping low-carbon, one-planet lifestyles.

Knowledge objects thus make visible alignments with a myriad of institutional logics, from the natural sciences to engineering traditions to artistic conventions, even within one community. Labs orient themselves in sundry ways to achieve the level of authority, 'accuracy', 'specialisation' or even 'unruliness' they see most appropriate to their future vision of 'sustainability'. This may mean partnering with chosen stakeholders, whether a research institute or a municipal library, and institutionalising proceeds according to these interactions (and conflicts). In some cases the lab seeks to maintain counter-culture alterity, acknowledging that the path entails high thresholds and impacts inclusivity: who is able to use the lab (Hielscher 2017). In still other cases the selection of collaborative partners is ad hoc, reactive rather than proactive and directed at ensuring short-term financial revenue.

For the FabLab network, open access and wide, all-inclusive participation in production is espoused as the primary objective. For the most strategic and enduring labs, however, participation is rather seen as a *means*, to get to a knowledge *end* the local lab must define (cf. Powell 2016), whether this is empowerment through experiential sustainability prototyping, development of biomaterials suitable for industrial machining, or knowledge creation for localised manufacturing. Each end entails different logics of design and meaning, from the artistic to the highly specialised, and each will involve its own trade-offs in terms of inclusion and exclusion.

ON IMAGINATIVE OBJECTS

As previously mentioned, much of the literature on FabLabs and open material peer production has tended to catalogue the most salient examples without deeper analysis. Particularly the open

source artefacts, such as the RepRap, that travel – and the mobility is quite well documented by the followers themselves – are used as symbols of the imminent peer production future, and they spark the imagination of others. What of projects that are not taken up: what are the reasons for their mutable immobility (cf. Latour 2005)? What of projects that are built but then not taken into routine use? What of projects that are regularly pointed out in tours of the lab, always in progress but never yielding visible outcomes? For example, FabLabs are particularly fond of prosthetics projects, as they have clear social benefit for marginalised groups and the nature of the product is entirely suited to low-cost customisation prototyping. (And this is not to say prosthetics are not being made and there are not users benefitting from them: I have witnessed several excellent examples.) But when I mentioned one such (European Union-funded) project casually to a long-experienced hacker, he replied, “Yeah, several labs were involved in draining funds from the EU, just *no one ever made a leg.*” Keeping in mind the intentional exaggeration here, ongoing, incomplete projects of this type are strongly symbolic – so much so that the lab itself does not always recognise how outsiders view them simply as projects unfinished and undelivered, in the most pragmatic sense.

The symbolism of sociomaterial FabLab projects cannot be over-emphasised. The network gives out Fab Awards to projects every year at the international meeting, sending a message to insiders of what activities are most valued and to outsiders of what types of ‘innovation’ are possible when peers work together without hierarchies or disciplinary boundaries. The projects displayed at SouthLab1 distinctly convey the topics of interest in this lab: renewable energy, permaculture and eco-building. The projects in CentralLab2, in contrast, signal a completely different orientation to sustainability – as well to FabLab materials and equipment.

It is late 2014. I am in a lab that continually perplexes me, wondering if it “is a FabLab”; if so,

why and if not, why not. The reason is the lab, or workshop, is filled with conventional woodworking tools, none of them computer controlled and therefore not ‘digital fabrication’ tools as in the FabLab parlance. (There is one new 3D-printer in the other room.) Members come here and make furniture and other projects, from reclaimed wood that has been discarded by other businesses throughout the large building in which the FabLab is housed. A lab board member tells me that reusing materials in furniture, especially well-designed furniture, teaches people from the neighbourhood how waste can be revalorised. For professional designers, the design competitions the FabLab hosts are intended to introduce eco-design and LCA (life cycle assessment) concepts in an entirely different way, an embodied and research-through-practice manner, where designers learn hands-on what it is to (in my own terms) design-for-reuse or design-for-disassembly.

It is a young lab, so the organisers are learning their relationship with their members, who should have a say in what the lab does and how feedback and decision-making should be organised. There will be a large CNC router acquired; use of the machine will be shared with another business in the building. There is a sudden meeting called: the lab manager stands up and calls the attention of all the members in the room and the wood workshop. Discussion on the CNC router ensues, particularly on the amount of the extra fees members should pay to access this machine. It becomes somewhat heated. (It is conducted in a language I do not know well so my fieldnotes are scant, but I am given a rough summary afterwards.) One of the lab employees appears quite moved subsequently, and he emphasises to me how significant the meeting was to the lab. He is full of praise for the lab manager for initiating this foray into self-organising and decision-making by consensus. It was brave, and a symbol of the future they want to co-create with their members.

In all respects, this was a FabLab. There was the guy working with Arduinos; the shy adolescent male

sitting off to the side; the anthropology student shadowing a user; a local journalist filming; the unreserved commitment of the employees, director and board members to allowing a space for people to make their own projects. There were material explorations, even a material library; the eccentric inventor and maker of curious objects; there was the same collection of books as in other labs, more or less; there were unfinished and finished projects in disarray. But I also felt to some extent I had travelled back in time, to the beginnings of the eco-design movement twenty years previously, where part of our exploration then was directed to the reuse and recycling of materials into new products. Have we not come further? Do we, as a design community, need to revisit this exploration space with each new generation?

I also wondered if this was the future, recognising the importance of material engagement in knowledge building, the way repair communities are operating in Europe today. What looks simply like repurposing material cast-offs into one-off and small-batch products could be deeply symbolic, redefinitions of 'waste' and the value of material. Especially in the context of this region, described to me as politically red-green and awash with cooperatives, the idea of a circular economy appears closer to implementation than abstract hype, with national legislation on circularity in development and the national minister of the environment coming to open this particular lab at its opening ceremony. This neighbourhood rallied and managed to close the nearby road, a major motorway, on a Sunday and took it over for a local festival. The design objects fabricated from reclaimed materials in the lab were displayed and sold to a receptive public. It is as easy to over-romanticise these efforts as it is to dismiss them as too local and situated to have true impact in socio-environmental terms.

As imaginative objects, these projects have the explicit goal of making visible and apparent supply chains and environmental issues in mass production, as well as opportunities for eco-design.

This FabLab was orienting more towards a traditional community-workshop institutional logic than a university engineering lab, and its activities and equipment were shaped accordingly. Other FabLab projects appear to have the reverse effect: imaginative objects symbolic of technology-driven, innovation-for-innovation's-sake logics obfuscate where components are made and under what working conditions, fail to acknowledge the global story of e-waste, and acquire materials and equipment according to cost and convenience rather than any principle of empowering local production. These imaginative objects act as membranes filtering out the inconvenient truths of DIY maker culture related to male-dominated (and Anglo-Saxon-dominated) engineering-culture histories; global energy problems (CNC equipment cannot operate without electricity); and deskilling – if the individual lab in question does not explicitly set out to address this invisibility.

Alignment to engineering technical cultures appears an easy default for FabLabs; unacknowledged, such default configurations lead facilely to 'expert rule and problems of gender-, class-based and racial exclusion' (Powell 2016, p. 613). The espoused objective of participation-for-all ironically results in an exclusive, elite space. When rather addressed as a *means*, however, the objectives of participation and openness prefigure procedures to prevent exclusionary practices from taking root. In the example described above, norms related to participatory governance were new for what was otherwise a conventional design association, but were taken into use – in a prototyping of alternative co-governance practices.

It appears FabLabs must make a choice. If they choose an orientation of Peer-Production-as-a-Service, a 'design-from-nowhere' model that seeks mainstream legitimacy, they have greater potential to reach a wider variety of users. But the more one opens the lab doors, lowers thresholds, enhances usability and makes DIY making accessible and easy, the more the revolution is tempered and FabLabs elide with business-as-usual.

Commodification means black-boxing procedures, which goes counter to the espoused objective of opening technologies. If, on the other hand, labs choose the anti-service, counter-culture, 'anarchist' institutional logics, they risk appealing to a tightly defined group that may find it difficult to evolve as conditions change or to collaborate on shared projects with wider impacts outside the lab doors. Founding principles are adhered to, but the lab can easily become an echo chamber that is oriented to individualism rather than collective good.

CONCLUSIONS: DESIGN FROM SOMEWHERE

This study has illustrated how material objects in FabLabs represent and embed institutionalising processes that orient the community to business-as-usual or alternative trajectories. Grassroots technology movements attempt to redress perceived inequalities by setting up counter-contexts (FabLabs) and reconstituting products, technologies and practices by establishing alternative norms and procedures. These dynamics are not only directed externally, as challengers to incumbent institutions in the dominant sociotechnical regime of mass production; they are also internal and within the counter-culture FabLab social world, as groups react to parts of the movement that consolidate power and produce discourses and practices that are found wanting. In institutionalising, FabLab managers thus find themselves constantly making decisions that land on a spectrum between open source and open doors. Open source requires particular protocols, governance models and ways of working that must be learned; open doors require a conforming of procedures and practices if they are to be taken up by the mainstream. Ideals oriented to alterity thereby easily become watered down, or ideals are maintained and the community becomes walled.

When variegated sociotechnical environments, histories, cultures and practices come together, work objects demarcate or meld 'seams'. Knowledge objects show how knowledge production for

sustainability is messy, situated, negotiated, ongoing and performative, deliberately not oriented to reductionist quick-fixes. Examining things in FabLabs as imaginative objects reveals what logics and systems of meaning gain staying power. Imaginative objects are in danger of remaining *too* incomplete, of *never making a leg* – but their very incompleteness appears to be pivotal to aspirations for transformation, ongoing prototypes of a grassroots-designed sustainable life. Things in FabLabs quickly become inevitable, taken for granted, invisible – yet they reveal much about how this collective intends to govern itself and accomplish things. FabLabs then need to routinely interrogate what forms of *openness* are aimed for, what they should deliver and what trade-offs are implied in their institutionalising pathways.

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REFERENCES

- Barad, K 2003, 'Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter', *Signs*, vol. 28, no. 3, pp. 801–831.
- Berg, M 1997, 'Of Forms, Containers, and the Electronic Medical Record: Some Tools for a Sociology of the Formal', *Science, Technology, & Human Values*, vol. 22, no. 4, pp. 403–433.
- Blumer, H 1969, *Symbolic Interactionism: Perspective and Method*, Prentice-Hall, Englewood Cliffs, NJ.

Bowker, GC & Star, SL 1999, *Sorting Things Out: Classification and Its Consequences*, The MIT Press, Cambridge, MA.

Buser, M and Carlsson, V 2017, 'What you see is not what you get: single-family house renovation and energy retrofit seen through the lens of sociomateriality', *Construction Management and Economics*, vol. 35, no. 5, pp. 276-28.

Büscher, M, Gill, S, Mogensen, P & Shapiro, D 2001, 'Landscapes of Practice: Bricolage as a Method for Situated Design', *Computer Supported Cooperative Work (CSCW)*, vol. 10, no. 1, pp. 1-28.

Callén, B, Sánchez Criado, T 2015, 'Vulnerability Tests: Matters of "Care for Matter" in E-waste Practices', *Tecnoscienza: Italian Journal of Science and Technology Studies*, vol. 6, no. 2, pp. 17-40.

Casper, MJ 1998, 'Negotiations, Work Objects, and the Unborn Patient: The Interactional Scaffolding of Fetal Surgery', *Symbolic Interaction*, vol. 21, no. 4, pp. 379-399.

Chalmers, M & Galani, A 2004, 'Seamful Interweaving: Heterogeneity in the Theory and Design of Interactive Systems', in *DIS '04: Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques*, pp. 243-252. ACM, New York.

Clarke, AE & Star, SL 2008, 'The Social Worlds Framework: A Theory/Methods Package', in EJ Hackett, O Amsterdamska, M Lynch & J Wajcman (eds) *The Handbook of Science and Technology Studies*, pp. 113-137. Third Edition, The MIT Press, Cambridge, MA.

Corvellec, H 2016, 'Sustainability objects as performative definitions of sustainability: The case of food-waste-based biogas and biofertilizers', *Journal of Material Culture*, vol. 21, no. 3, pp. 383-401.

de Saille, S 2015, 'Dis-inviting the Unruly Public',

Science as Culture, vol. 24, no. 1, pp. 99-107.

Dickel, S, Ferdinand, JP & Petschow, U 2014, 'Shared Machine Shops as Real-life Laboratories', *Journal of Peer Production*, vol. 5. Available from: <http://peerproduction.net/issues/issue-5-shared-machine-shops/peer-reviewed-articles/shared-machine-shops-as-real-life-laboratories/> [27 April 2018].

Dunbar-Hester, C 2014, 'Radical Inclusion? Locating Accountability in Technical DIY', in Ratto, M & Boler, M (eds) *DIY Citizenship: Critical Making and Social Media*, pp. 75-88. The MIT Press, Cambridge, MA.

Flanagan, M, Howe, DC & Nissenbaum, H 2008, 'Embodying Values in Technology: Theory and Practice', in van den Hoven, J & Weckert, J (eds) *Information Technology and Moral Philosophy*, Cambridge University Press, Cambridge, UK.

Friedland, R, Alford, R 1991, 'Bringing Society Back In: Symbols, Practices, and Institutional Contradictions', in Powell, W & DiMaggio, P (eds.) *The New Institutionalism in Organizational Analysis*, University of Chicago Press, Chicago.

Gershenfeld, N 2005, *FAB: The Coming Revolution on Your Desktop - From Personal Computers to Personal Fabrication*, Basic Books, New York.

Gershenfeld, N 2012, 'How to Make Almost Anything', *Foreign Affairs*, vol. 91, no. 6, pp. 43-57.

Hess, DJ 2005, 'Technology- and Product-Oriented Movements: Approximating Social Movement Studies and Science and Technology Studies', *Science, Technology, & Human Values*, vol. 30, no. 4, pp. 515-535.

Hess, DJ 2016, *Undone Science: Social Movements, Mobilized Publics, and Industrial Transitions*, The MIT Press, Cambridge, MA.

Hielscher, S 2017, 'Experimenting with Novel Socio-Technical Configurations: The Domestication of Digital Fabrication Technologies in FabLabs', *Digital Culture & Society*, vol. 3, no. 1, pp. 47-72.

Hobson, K 2016, 'Closing the loop or squaring the circle? Locating generative spaces for the circular economy', *Progress in Human Geography*, vol. 40, no. 1, pp. 88-104.

Hyysalo, S 2010, *Health Technology Development and Use: From Practice Bound Imagination to Evolving Impacts*, Routledge, New York.

Jarzabkowski, P & Pinch, T 2013, 'Sociomateriality is "the New Black": accomplishing repurposing, reinscripting and repairing in context', *M@n@gement*, vol. 16, no. 5, pp. 579-592.

Knorr Cetina, K 1997, 'Sociality with Objects', *Theory, Culture & Society*, vol. 14, no. 4, pp. 1-30.

Kohtala, C 2017, 'Making "Making" Critical: How Sustainability is Constituted in Fab Lab Ideology', *The Design Journal*, vol. 20, no. 3, pp. 375-394.

Kohtala, C & Bosqué, C 2014, 'The Story of MIT-Fablab Norway: Community Embedding of Peer Production', *Journal of Peer Production*, vol. 5. Available from: <http://peerproduction.net/issues/issue-5-shared-machine-shops/peer-reviewed-articles/the-story-of-mit-fablab-norway-community-embedding-of-peer-production/> [27 April 2018].

Latour, B 2005, *Reassembling the Social: An Introduction to Actor-Network Theory*. Oxford University Press, Oxford.

Latour, B & Woolgar, S 1986 [1979], *Laboratory Life: The Construction of Scientific Facts*, 2nd edn. Princeton University Press, Princeton, NJ.

Law, J 2004, *After Method: Mess in Social Science Research*, Routledge, London.

Leadbeater, C 2014, 'Hooked on Labs', *The Long and the Short* [NESTA online magazine], 27 November. Available from: <https://thelongandshort.org/spaces/experimental-innovation-labs> [27 April 2018].

Maldini, I 2016, 'Attachment, Durability and the Environmental Impact of Digital DIY', *The Design Journal*, vol. 19, no. 1, pp. 141-157.

Marres, N 2015, *Material Participation: Technology, the Environment and Everyday Publics*, 2nd edn, Palgrave Macmillan, Houndmills, UK.

Menichinelli, M, Bianchini, M, Carosi, A & Maffei, S 2017, 'Makers as a New Work Condition between Self-Employment and Community Peer-Production: Insights from a Survey on Makers in Italy', *Journal of Peer Production*, vol. 10. Available from: <http://peerproduction.net/issues/issue-10-peer-production-and-work/peer-reviewed-papers/makers-as-a-new-work-condition-between-self-employment-and-community-peer-production-insights-from-a-survey-on-makers-in-italy/> [27 April 2018].

Nascimento, S & Pólvara, A 2016, 'Maker Cultures and the Prospects for Technological Action', *Science and Engineering Ethics*, 7 July, pp. 1-20.

Neale, W & Hobern, C 2017, 'Innovation begins with inclusion: Integrating the Fab Charter into every day at Fab Lab Wgtn', in: *Proceedings of the Fab13 Research Stream*. Available from: <https://archive.org/details/Fab13NealeHobern> [27 April 2018].

Orlikowski, WJ 2000, 'Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations', *Organization Science*, vol. 11, no. 4, pp. 404-428.

Ottinger, G 2010, 'Buckets of Resistance: Standards and the Effectiveness of Citizen Science', *Science, Technology, & Human Values*, vol. 35, no. 2, pp. 244-270.

Papadopoulos, D 2015, 'From Publics to Practitioners: Invention Power and Open Technoscience', *Science as Culture*, vol. 24, no. 1, pp. 108-121.

Pfaffenberger, B 1992, 'Technological Dramas',

Science, Technology, & Human Values, vol. 17, no. 3, pp. 282–312.

Powell, A 2016, 'Hacking in the public interest: Authority, legitimacy, means, and ends', *New Media & Society*, vol. 18, no. 4, pp. 600–616.

Ratto, M 2011, 'Critical Making: Conceptual and Material Studies in Technology and Social Life', *The Information Society*, vol. 27, no. 4, pp. 252–260.

Sadler, S 2012, 'The Dome and the Shack: The Dialectics of Hippie Enlightenment', in Boal, I, Stone, J, Watts, M & Winslow, C (eds) *West of Eden: Communes and Utopia in Northern California*, pp. 72–80. PM Press, Oakland, CA.

Schor, JB, Fitzmaurice, C, Carfagna, LB, Attwood-Charles, W & Poteat, ED 2016, 'Paradoxes of openness and distinction in the sharing economy', *Poetics*, vol. 54, pp. 66–81.

Smith, A, Fressoli, M, Abrol, D, Arond, E. & Ely, A. 2017, *Grassroots Innovation Movements (Pathways to Sustainability)*, Routledge, Abingdon, UK.

Smith, A, Raven, R 2012, 'What is protective space? Reconsidering niches in transitions to sustainability', *Research Policy* vol. 41, pp. 1025–1036.

Strauss, A 1978, 'A Social World Perspective', in Denzin, NK (ed) *Studies in Symbolic Interaction: An Annual Compilation of Research*, pp. 119–128. Jai Press, Greenwich, CT.

Suchman, LA 1987, *Plans and Situated Actions: The Problem of Human-machine Communication*. Cambridge University Press, Cambridge, MA.

Suchman, L 2000, 'Located Accountabilities in Technology Production' [Working Paper]. Centre for Science Studies, Lancaster University, Lancaster, UK. Available from: <http://www.lancaster.ac.uk/fass/resources/sociology-online-papers/papers/suchman-located-accountabilities.pdf> [27 April 2018].

Toombs, A 2016, *Care and the Construction of Hacker Identities, Communities, and Society*, Doctoral Dissertation, Indiana University School of Informatics and Computing.

Toombs, A, Bardzell, S & Bardzell, J 2014, 'Becoming Makers: Hackerspace Member Habits, Values, and Identities', *Journal of Peer Production*, vol. 5. Available from: <http://peerproduction.net/issues/issue-5-shared-machine-shops/peer-reviewed-articles/becoming-makers-hackerspace-member-habits-values-and-identities/> [27 April 2018].

Troxler, P 2014, 'Fab Labs Forked: A Grassroots Insurgency inside the Next Industrial Revolution', *Journal of Peer Production*, vol. 5. Available from: <http://peerproduction.net/issues/issue-5-shared-machine-shops/editorial-section/fab-labs-forked-a-grassroots-insurgency-inside-the-next-industrial-revolution/> [27 April 2018].

Vertesi, J 2014, 'Seamful Spaces: Heterogeneous Infrastructures in Interaction', *Science, Technology, & Human Values*, vol. 39, no. 2, pp. 264–284.

Wartofsky, MW 1979, *Models: Representation and the Scientific Understanding*, (Boston Studies in the Philosophy of Science), D. Reidel Publishing Company, Dordrecht, the Netherlands.

Wu, Y, Whalen, J & Koskinen, I 2015, "'Nothing Makes Sense": New Aesthetics in Self-Organizing Services', in Bihanic, D (ed) *Empowering Users through Design: Interdisciplinary Studies and Combined Approaches for Technological Products and Services*, pp. 249–266. Springer International Publishing, New York.

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APPENDIX 1

Table 1: summary of research sites

LAB	TYPE	AGE OF LAB AT TIME OF VISIT. FOUNDED YEAR	DURATION OF VISIT	INTERVIEWS	OTHER DATA
NorthLab1	university-hosted (art, design, media school); in medium-sized city in the Nordic countries.	from 0 to 3 years. 2012	longitudinal ethnography (3 years) late 2011-early 2015	19 interviews with 13 people (on average about one hour each) (fully transcribed)	1150 photos, 5.5 hours of video, 79 sets of fieldnotes
NorthLab2	independent: owner-operated (family run); in small village in the Nordic countries.	10 years. 2002	3.5 days, autumn 2012	3 interviews with 2 people (average 75 minutes each) (fully transcribed)	200 photos, 5 sets of fieldnotes
SouthLab1	university hosted (architecture school). in peri-urban area of large city in Spain.	5 years, 7 years. 2008	2 days, summer 2014	2 interviews with 2 people) (about 20 minutes each) (mainly transcribed with extensive notes)	110 photos, 2 sets of fieldnotes
			1 day, summer 2016	2 interviews with 2 people) (one hour, half an hour) (mainly transcribed with extensive notes)	155 photos, 1 set of fieldnotes
SouthLab2	independent: owner-operated. in small city in Spain.	half a year. 2013	0.5 day, summer 2014	1 interview/ conversation with 1 person (30 minutes, notes)	60 photos, 1 set of fieldnotes
DutchLab1	art association hosted. in medium-sized city in Benelux.	about 5 years, 7 years. 2007	1 day, summer 2012	1 interview with 1 person (one hour, extensive notes, partly transcribed)	110 photos, 1 set of fieldnotes
			1 day, winter 2014	4 interviews with 3 people (from 20 mins to one hour) (mainly transcribed, extensive notes)	50 photos, 1 set of fieldnotes

DutchLab2	professional industry association-hosted. in medium-sized city in Benelux.	6 years. 2008	1 day, winter 2014	1 interview with 1 person (1.5 hrs) (mainly transcribed, extensive notes)	80 photos, 1 set of fieldnotes
DutchLab3	independent: owner-operated. in medium-sized city in Benelux.	about 1 year. 2013	half a day, winter 2014	1 interview with 1 person (1.5 hrs) (mainly transcribed, extensive notes)	30 photos, 1 set of fieldnotes
DutchLab4	independent: owner-, art collective-, volunteer-operated; in small city in Benelux.	4 years, 6 years. 2010	1 day, autumn 2014 2 days, summer 2016	5 interviews with 4 people (average 30 minutes each) (includes interview with founders in 2012) (partially transcribed with extensive notes)	100 photos, 1 set of fieldnotes 215 photos, 2 sets of fieldnotes, 3 hours recorded conversations and presentations, some video (partly transcribed)
DutchLab5	independent: owner-operated. in small city in Benelux.	almost 5 years. 2010	half a day, autumn 2014	1 interview with 1 person (one hour) (partially transcribed with extensive notes)	60 photos, 1 set of fieldnotes
DutchLab6	independent: owner-operated; in small city in Benelux.	10 months. 2014	2.5 days, autumn 2014	3 interviews with 2 people (average 30 minutes each) (includes short interview with founder earlier that year) (fully transcribed)	115 photos, 3 sets of fieldnotes
DutchLab7	independent: owner-operated. in medium-sized city in Benelux.	2 years. 2013	half a day, winter 2014	1 interview with 1 person (20 minutes, on video) (fully transcribed)	35 photos, 1 set of fieldnotes
CentralLab1	municipality-hosted. in small city in Benelux.	2 years. 2012	2 days, winter 2014	7 interviews with 5 people (from half an hour to 1,5 hrs) (includes previous interviews with two founders, 2012, 2014) (partly transcribed with extensive notes)	170 photos, 3 sets of fieldnotes

CentralLab2	professional industry association hosted; in small city in France (adjacent to large city)	about 1 year. 2014	2 days, autumn 2014	8 interviews with 4 people (average 30 minutes each) (includes short interview with founder earlier that year) (partially transcribed with extensive notes)	130 photos, 2 sets of fieldnotes, some video and audio of lab conversations
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THE INSTITUTIONALIZATION OF MAKING: THE ENTREPRENEURSHIP OF SOCIOMATERIALITIES THAT MATTERS

Evelyne Lhoste, Marc Barbier

In France, makerspaces have been institutionalized and popularized by the generalization of the label “Fab lab”, which is common to many discourses on innovation, is supported by public authorities and recognized by corporate business and high ranked universities. However, the initial structuration needs to be analyzed “from below” to understand how making at the local level is coupled to institutional entrepreneurship. The present paper focuses on the process of creation and development of makerspaces since the emergence of the French “Fablab fashion”. Our analysis is based on a sociological and ethnographic enquiry which started in 2012 (Lhoste and Barbier, 2016). A practice-based approach allows us to question how a field of situated maker practices is related to the organizational arrangements of a plurality of stakeholders, enrolled on premises of innovation and entrepreneurship. The description of practices is grounded in a structural model in which human actors, technological artifacts and organizations are closely intertwined. We address the following empirical research questions: How are sociomaterialities performed and organized in practice? How are a certain style of making practices and identity of practitioners progressively institutionalized and demonstrated at the local and global levels? Fablabs emerge as organized spaces where practices have agency and articulate knowing in practice with a proto-organization. Studying this process allows to understand how practices are related to the institutionalization of Fablabs at the local and global levels. We highlight the role played by Fabmanagers as intermediary agents, and how their various activities affect the achievement of the initial goal of the project proponents.

Keywords: makerspace, structuration theory, practice-based approach, institutional entrepreneurs, organizational learning

by Evelyne Lhoste & Marc Barbier

INTRODUCTION

The brand Fab Lab originated at the Massachusetts Institute of Technology (Gershenfeld, 2005; Kohtala and Bosqué, 2014), and has been popularized in the media, government and academia. The term is linked to the discourses on digital fabrication and innovation opportunities, and refers to digital fabrication workshops which promise democratization of innovation through the large availability of machines and shared knowledge. These hybrid and transitional collectives are part of a dynamic of the institutionalization of the maker

culture based on collaborative practices (Kohtala et al., 2014; Troxler, 2014, Fleischschmann et al 2016), sometimes viewed as the “next generation of the hackerspace evolution” (Maxigas, 2012) or the “third places of soft hacking” (Lhoste and Barbier, 2016). Meyer (Meyer, 2015) describes this dynamic as driven by the “positive virality of garage practices” which allows out-of-the-box innovation in an established techno-scientific framework. This movement shows continuity with several other movements such as the counter-culture (Turner, 2010), commons-based peer production collectives (Benkler and Nissenbaum, 2006; Kostakis, Niaros, and Giotitsas, 2014), free and open source technologists (Broca, 2013; Kelty, 2008), do-it-yourself and repair groups (Rumpala, 2014), and

arts and crafts (Krugh, 2014). In France, Fablabs have emerged as community-based or university-based places, some running experiments with the social and solidarity economy, and others more oriented toward traditional business models (Bosqué et al., 2014; Lhoste and Barbier, 2016; Mérindol et al., 2016). In broader terms, they constitute places “supported by diverse groups of actors, which aim to renew modalities of innovation and creation by employing open, collaborative and iterative processes to materialize physically or virtually” (Mérindol et al., 2016), *our translation*).

In this article, we posit that the celebration of these new modalities of innovation could blur the understanding of the transformative agency of Fablabs, and their contribution to the situated generalization of collaborative practices in the making. We ground our analysis in the structuration model proposed by Orlikowski and Scott (Orlikowski and Scott, 2008), to shed light on the creation and development of Fablabs. In this interpretative model, the concept of sociomateriality frames an examination of the constitutive entanglement of the social and material in everyday life and workplace organization (Orlikowski, 2007). This perspective which is strongly related to the “practice turn” in organization studies (Gherardi, 2000), allows identification of the shifting boundaries between human and material agencies during practice, rather than defining fixed relations prior to action. Considering Fablabs as organized spaces where practices have agency and articulate knowing in practice with a proto-organization, we hope to understand how the “formativeness” and the “agencement” (Gherardi, 2016) of situated practices are related to the process of institutionalization. To analyze the process leads to the study of the practices of those who are interested in both the development of human and material agencies and the institutionalization of Fablabs. It allows us to reveal the boundary work they perform at multiple organizational levels. Thus, we contribute to the framing of a grounded perspective of the organizational dimension on community-based innovation processes. These theoretical

underpinnings allow investigation of the following empirical research questions: How are sociomaterialities performed and organized in practice? How are a certain style of making practices and identity of practitioners progressively institutionalized and articulated at the local and global levels?

The paper is organized as follows. Sections 2 and 3 describe the analytical and methodological frameworks. Section 4 discusses the genealogy for adaptation of the MIT model to a French perspective. Section 5 describes the process of institutionalization, and compares types of institutional boundary work performed in diverse Fablabs. This provides insights into the distribution of institutional entrepreneurship among human actors, artifacts and organizations. Section 6 concludes with a discussion of the concept of distributed institutional entrepreneurship and how human and material agencies are interlocked during practice, to produce Fablabs as complex sociomaterialities and to transform both organizations and the Fablab concept. We highlight how the negotiations of a diversity of practitioners at the local level institutionalize a practice style and influence achievement of the initial goals of the project proponents.

ANALYTICAL FRAMEWORK

In the organization studies literature, institutionalization is the process that enables patterned relations and actions to “gradually acquire the moral and ontological status of taken-for-granted facts which, in turn, shape future interactions and negotiations” (Barley and Tolbert, 1997). Based on this definition, we analyze institutionalization of the maker culture as the co-creation of sociomaterialities that enables simultaneously makers’ practices and the stabilization of standards and norms related to the design and use of the places where these practices are performed. Understanding this structuration process is rooted in a sociology of organizations that has prevailed since Anthony Giddens’s work on

social structuring in practice in which human actions are enabled and constrained by structures that are the result of previous actions. In this framework, activities are negotiated collectively at the interface of structure and agency. Human agency is “the ability to form and realize one’s goals” (Giddens, 1984) using rules and resources which constitute the social structure. As a consequence, the social structure may be either reaffirmed or changed. When analyzing practices in organizations, we need to ask how individual and collective human agencies negotiate compromises in action, and how the human and non-human elements are interwoven and stabilized. By introducing materiality into human agency, the structurational model of technology (Orlikowski, 1992) overcomes the dualism between the objective, structural features of technologies on the one hand, and the subjective, knowledgeable action of human agents on the other. The concept sociomateriality intertwines practice with the technology in which it is embedded (Orlikowski, 2007). This term reminds us that materiality is present in every social activity. In referring either to technologies or organizations, any social practice is possible because of some materiality, and it shapes the materiality of a technology and its effects (Leonardi, 2012). Over time, the technology and the artifacts produced during the enacting of structures may reinforce (perform) or transform (re configure) the existing configurations (Orlikowski and Iacono, 2000). Examination of these (re)configurations allows us to identify the shifting boundaries that occur between human and material agencies during practice, rather than defining fixed relations prior to action.

This framework helps to explain how the ongoing activities of human agents drawing on digital fabrication are objectified and institutionalized without being rationalized. Exploring the process of institutionalization of Fablabs equates with examining how the structuration process is enabled and sustained, and how it receives organizational impetus over time. As Lawrence et al. (Lawrence et al., 2001) suggest, the temporal dynamics of institutionalization in knowledge organizations leads

to the study of institutional entrepreneurship. Here, institutional entrepreneurship refers to the “activities of actors who have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones” (Maguire et al., 2004). Paying attention to the design and establishment of Fablabs by entrepreneurial intermediaries – Fabmanager or founders – sheds light on how sociomaterialities are organized through the practices of institutional entrepreneurship that establish and legitimize Fablabs as places for making. Tracey et al. (Tracey et al., 2011) insist on the “multilevel nature of bridging institutional entrepreneurship, showing that it entails institutional work at the micro, meso, and macrolevels”. Maguire et al. (Maguire et al., 2004) following Fligstein (Fligstein, 1997), underline that institutional entrepreneurship depends on the existence or the stability of an organizational field.

In line with this literature, Fablabs could be explored as organizations supported by various structuration activities which indicate the establishment of an organizational field: networking of community-based initiatives and practices, design and support of a standard and associated definitional struggles, private and public support at various levels. Therefore, the institutional boundary work of Fabmanagers should not be considered as driven purely by the micro-logics of the sociomaterialities of the makerspace. It is also grounded in the emerging attention of policy makers and incumbent actors for Fablab initiatives. The notion of sociomateriality unfolds in institutional entrepreneurship over time and space through a series of technologies and artifacts produced by the actors in their practice, and progressively equip the Fablab within and outside its material walls. It is articulated at two organizational levels: 1. By giving substance to the local networks of users, it sets the place and space of sociomateriality, 2. By attracting public and private resources and support, it establishes the long run settings. These entrepreneurship activities shed light on the boundary work of those agents described by

Cecchini and Scott (Cecchini and Scott, 2003) as “grassroots intermediaries” who assemble all the entities involved in the process at various organizational levels. Ultimately, it reveals how the performativity of the MIT Fablab format is gradually performed through the activities of humans mobilized in the design and production of a Fablab embedded in the existing institutional environment.

METHODOLOGY

To conduct our investigation on sociomaterialities, we studied Fablabs that were materialized by the MIT Fablab logotype, referred to the Fab Charter, and claimed to be fully open. This quite strict empirical delimitation allows comparability since commitment to a charter establishes a common attitude of institutional entrepreneurs towards what needs to be institutionalized. The first empirical data were collected from a set of 37 interviews conducted between November 2012 and June 2013

in 7 Fablabs (Lhoste, 2013; Lhoste and Barbier, 2016). The interviewees were users and, depending on the hosting organization, founders, fabmanagers and science explainers. In 2016-2017, we conducted a second set of 30 interviews in and around 4 of the Fablabs involved in the first interview round, focusing on Fabmanagers, project managers and stakeholders. Evelyne is also engaged in regular participative observations in Fablabs and social events. We collected material settings in the Fablabs, along with digital traces on websites and blogs, and documents such as guides, charts, official reports and press clippings. Coding and analysis of the empirical materials were performed using NVIVO CAQDAS software which is known to be effective for this type of approach. We aimed at comparability, and systematically characterized the situation of each Fablab based on qualitative variables used to organize our interviews and observations to target the main objects of our enquiry: the discourses and practices of the actors involved in the lives of the Fablabs and their foundation (Table I).

Organization of Space and time	Surroundings of the site, surface area, opening hours, conditions of privatization
Material devices and artefacts	Digital and conventional equipment, furnishing, appliances, adornments, arts and crafts.
Accessibility and social grid	Opening hours, rates of access, participation of users in collective tasks, presence of employees
Relationship to surrounding institutions	Financing, origin of founders and fabmanager, attitude towards conventions and norms
Users’ practices	Type of activities, form of sociabilities in making
Knowledge production and circulation	Organization of training sessions, spontaneous exchange of tacit knowledge, education, project participation, documentation

Table I. Descriptive framework

Building on this empirical approach, we structured the field of our enquiry to account more precisely for Fabmanagers’ boundary work and activities. The number of discourses, research studies and scientific discussions on Fablabs grew during the progressive structuring of our findings resulting in our organizing them according to the grounded

theory presented in the previous section (Figure 1).

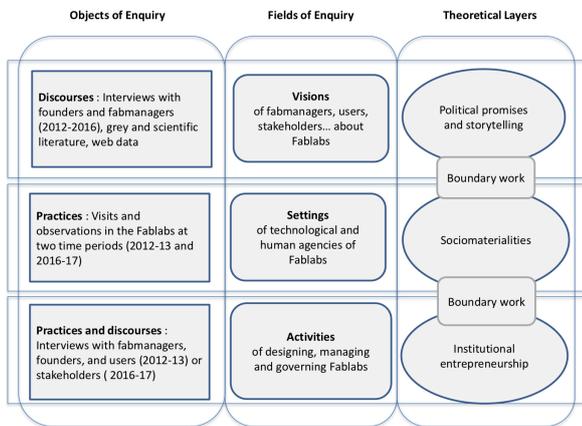


Figure 1: Linking collected material to theoretical framework: correspondence between discourses and practices, fields of enquiry and theoretical layers.

RESULTS 1: THE DYNAMICS OF THE EMERGENCE OF THE FABLAB MOVEMENT

Over the past 10 years, the term Fablab has become more common in discourses on innovation and public policies, and the maker culture triggered several initiatives, whether registered directly as Fablabs or not. We authored a previous socio-historical account of the opening of Fablabs (Lhoste and Barbier, 2016). Here, we contextualize the emergence of Fablabs in France taking account of the worldwide movement. The Fablab network spurred around the world following the award to the MIT's Center for Bits and Atoms (MIT-CBA) of a grant from the National Science Foundation for an outreach program in 2003 (Kohtala and Bosqué, 2014). These authors describe how the Fablab network was shaped by MIT-CBA and the situated interactions of charismatic storytellers with local

stakeholders, similar to what Troxler ((Troxler, 2014)) describes in the case of the Dutch movement. In 2008, an article on digital tinkering published in a top French political newspaper did not even mention Fablab. This very same year, a computer sciences engineer created a non-profit association aimed at establishing a Fablab in Toulouse (see citation in Table 2A). With a colleague, he organized shoptalks in community rooms, and participated in a shared knowledge festival organized in the area. This sets the information and communication goals required to form a community. Thanks to these individuals' academic links, by the end of 2009, the first digital equipment received public funding, and they were able to hold their meetings in a small room at Toulouse University before moving to a larger space in the basement of a community member's house. They were active in contacting town councilors and fostering ties to the international Fablab movement. In 2010, Artilect was given Fablab status by the Fab Foundation, and obtained financial support from the European Social Fund. Its founders attended the first international Fabconference to be held in Europe where they were introduced to a French think-tank created in 2000 to prepare for digital transitions (Bottollier-Depois, François et al., 2014). In 2012, the urban community "Toulouse Metropole" rented an ancient *chaudronnerie* to open a third place, "Le multiple", which was occupied mostly by Artilect. According to its website, the Artilect community includes 1,000 members. The cost of membership is cheap, and the lab is open six days a week. It experiments with business models to hybridize non-profit and for-profit activities. With the help of the community, the fabmanagers organize training sessions, and regular events including the annual Fabfestivals (9,000 visitors and over 200 volunteers in 2017).

Name	Origin of the Project	Citations of founders telling their motivations to start a Fablab	Net-iki
Artilect	Grassroots = a computer engineer	"I did my post doc at Cornell University, in the lab led by Lipson who is at the origin of Fab@home, it is a concept very close to the Fablabs. I also met Neil Gershenfeld. We created an association with the goal of decompartmentalization, of interdisciplines. It is important to see a problem from different angles. It's pretty weird to say we're in the lab with 400 people who have the same profile. Diversity is a bit like what they had in Cornell..."	Grassroots = members of a socio-cultural association acting for High rate internet access in their rural area "Why a fablab? Already this is the first thing we saw happening and that resembled our problems. I was thinking about co-working too. But I saw the fablabs go by and I thought that the material was important 3D materializes things ..."

NYBI.CC	Grassroots = a group of makers/hackers	"For a living, I work in 2 startups from computer research ... I am a doctor and engineer. I introduce myself as co-founder. How did it start? I do a lot of watching on the Internet and I followed the evolution of fablab. What I started to do is create a website. I ordered a Reprap kit, found some friends to mount it. I talked about it. I published it in the hackerspace list when we did not have the local or anything. The other big meeting was with (another maker) at FING in Paris."	La Casemate	6 science center managers submitted a proposal to a national Call launched by the French Ministry of Research and Education.	"Digital is anchored in our practices. In 99, we opened the first internet place open to the public. ... We will not help innovation by doing workshops on dinosaurs."
Faclab	Two University professors (entrepreneurs and makers)	"To sum up initially it's a personal craving, basic sharing needs, to see that the wave of personal fabrication is coming up. We start with the Forge (another Fablab they created) ... And there we make a mistake, we speak about it to the director of the University ... He introduces us to the vice-president. We show the first of the 4 slides of our PowerPoint when he interrupts us. He says OK I understood I want one ..."	Carrefour numérique2	"There was no line for scientific culture in the Grand Emprunt (a national Project call on Research and Education). So we mobilized. ... to open it, the people who knew each other discussed and decided to get together to write a proposal ... It's a bottom-up approach."	"I suggested to submit the idea of fablabs in the Inmediat project... In the other fablabs, they do not think in terms of public attendance and they are looking for a business model. For us, how we will articulate both the general public and the rest ... Politically, it would be extremely difficult to take 6 million euros to accommodate 200 people!"
Faclab			Le Dôme		

Table 2A. Origins of the Fablabs projects and motivation of founders in 7 fablabs. Adapted from Lhoste 2013, our translation.

This narrative exemplifies the boundary work of founders who gradually and diachronically built the Fablab and the community, and enrolled public stakeholders to support it. In the early 2010s, there were some 20 Fablabs established in various cities and towns, as the result of the initiatives of early adopters and other grassroots intermediaries (Table 2A). Members of this emerging community began meeting in 2011 during various events including a machine construction bootcamp organized in Nantes and the first French Fablab conference held in Toulouse. In 2013, our early cross cutting analysis (Table 2B) showed that they were places with varying degrees of membership formalization, flexible access, and openness to public participation. The user's activities were very diverse. While making involves programming, electronics and digital fabrication, it spans many other hands-on activities as situated practices. Most claimed an attachment to the values of other social and environmental movements such as upcycling, community gardens and repair cafés (Rumpala, 2014). This laid the foundations for a French network of Fablabs which was formalized in 2016 through an association. In 2017, France had the highest number of Fablabs after the US, registered on the Fab Foundation website (fablab.io). Fablabs

have been established in both urban and rural environments, in community centers, science centers, universities and other organizations more or less oriented towards education, innovation and contribution to the maker movement. They are aimed not just at market-oriented innovation; their governance often emphasizes social values over business, and most are subsidized by local and national public authorities (Mérindol et al., 2016).

Concomitantly, many public authorities at the local, regional and national levels welcomed this flourishing initiative. In 2012, the French Ministry of Higher Education and Research awarded funding to six science centers to update *Culture scientifique et technique* (a concept close to science, technology, engineering, the arts and mathematics (STEAM) and public understand of science in a diffusionist approach) with digital technologies. In 2013, the French Ministry of Industry supported 14 so-called Fablabs through the National Innovation Program oriented towards entrepreneurship. One hundred of the 800 public computing drop-in centers that emerged across the country during the early 2000s have been transformed into Fablabs. In 2016, more and more territorial communities (from cities to regions) were contributing to the structuration of territorial networks of Fablabs. In addition to the provision of public funding, several private foundations are supporting Fablabs engaged in education projects.

Name	Artilect	Casemate	Net-iki	NYBI.CC	Faclab	Carrefour numérique 2	Le Dôme
City	Toulouse	Grenoble	Biarne	Nancy	Genevilliers	Paris	Caen

Self-Rating MIT	AAAB	AAAA	AAB+B	AACA	AABB (aiming AAAA)		
Open Since	2009	2011	2011	2011	2012	2014 (on beta test in november 2012)	2015 (on beta test in june 2013)
Hosting Organisation	NGO	NGO (Science center)	NGO (community center)	NGO	Cergy-Pontoise University	National Museum	NGO (science center)
Funding	public	public	public and private	none	public and private	public funding	public funding
Membership (indicated prices are for individuals)	30 euros/year	No (pay access to digital equipment)	15 euros/year	120 euros/year	No	No (pay access to equipment)	10 euros per month (+ symbolic fee to digital equipment and training sessions)
Number of members	100	391 access cards	70	26 in 2012	15 regular users	individuals and out of school groups	a dozen betatesters
Number of visitors	Founder, fabmanager and volunteers	Fabmanager + science explainers	volunteers	volunteers	fabmanager (facilitator)	fabmanager and science explainers	fabmanager
Staff		8766 (3300/year)	235	10-20/week	5563 (3500/year)		70/month
Location	1600 m2 in open space	120 m2	70 m2	60 m2	160m2	400m2 in a 1000 m2 open lab	
Digital equipment	2 laser cutters, vinyl cutter, 4 3D printers, milling machine	laser cutter, vinyl cutter, 3D printers, 2 milling machines	3D printer	3D printer	laser cutter, vinyl cutter, 2 3D printers, milling machine	3D printer	3D printer

Table 2B. Analytical description of 7 Fablabs included in the case study. Adapted from Lhoste, 2013.

This dynamics has been sufficiently important for the actors to count themselves and demonstrate to the rest of the world how numerous they are. Since

2011, Fabmanagers have registered on the official website Fablab.io. The registration and self-rating based on Fab Charter criteria allowed them to use the logotype. This flexible procedure has facilitated the further spreading of Fablabs. Indeed, the term Fablab was used strategically to avoid explicit reference to the hacker culture:

"To communicate with the word hackerspace is not obvious. And then there is the fact that there is a charter in the Fablabs. That way we're pretty sure of the color of the sheep." (Core member, Net-iki, 2013)

"We are more open (than a hackerspace), a bit like a makerspace. On the institutional side, the term Fablab is better. We are opportunists ... Fablab, hackerspace, makerspace, we do the same things. But it is the values put forward that are different." (Core member 2, Nybi.CC, 2013)

In 2017, the website of the French Fablab network (www.fablab.fr/) refers both to the fablab.io website and the mastery.info cartography, itself being based on diybio.org, hackerspace.org and fablab.io, translates the blurring boundaries between the fabber/maker/hacker communities in France. According to these websites, the French spelling of Fablab has not been formalized; the use of capital letters have a tendency to disappear as if the Proper noun "Fab Lab" is being transformed into a generic term, fablab. The term Fablab is used well over the Fablab network in media and institutions (corporate business, top class universities and French engineering schools, public organizations such as the Ministry of National Education and institutions such as *Culture scientifique et technique...*). We are therefore witnessing a process in which the actors are putting a label on what they are designing. As a matter of fact, the relations of French Fablabs with the Fab Foundation and the rest of the global network are as diverse as the spelling is unstable. Artilect and a few other Fablabs have developed individual relationships with the Fab Foundation through participation in FabAcademy training programs. Many of these relationships are based on personal links between the Fabmanagers and MIT-CBA. Others interact with foreign Fablabs based on EU funded networks or on *Francophonie*. As an acknowledgement of this complex networking, the

French Fablab network is co-organizing the 14th international FabConference in 2018. It will be held in two registered FabCities, Paris and Toulouse and distributed events will take place in territories.

In line with Orlikowski and Iacono's (2000) observations on technologies and organizations, "gurus", grassroots initiatives and public policy instruments are not the only key actors shaping Fablabs for particular organizational or socio-economic ends. Once an innovation is deployed, its developers and managers have little control over how specific workgroups and teams will use it and shape it to their own needs. For this reason, it is important to take account of the practices in a given environment and to observe the structuring of the daily life of Fablabs inhabited by people and objects. The concept of sociomateriality is a resource to allow differentiation between "espoused technologies" and "technologies in use" (Orlikowski and Iacono, 2000). Therefore, we will now focus on situated practices and interviews with practitioners.

RESULT 2: SOCIOMATERIALITIES AS IDENTIFIERS OF INSTITUTIONAL ENTREPRENEURSHIP

To further investigate how the Fablab model has been enacted by its users, we focus next on the results of our observations of situated practices and interviews with practitioners. The general descriptive framework presented in Table 1 covers the heterogeneous structuration: the architecture of its space and time, its business model and openness, the socio-professional trajectory of its team leaders, users' productions and participation in the process, and their discourses and activities. In order to describe institutional entrepreneurship, we report the sociomaterialities of seven Fablabs studied in 2013 (Table 2B) and in four of them, compare the subsequent activities performed in 2017 (Tables 3A and B).

Name
City

Faclab
Genevilliers

Designing and organizing the place	Surroundings of the place	Genevilliers is a popular and multicolored city in the North of Paris. The building is located on a large road lined with office buildings
	Facilities	The Faclab is situated on the ground level of a university building with access from the main hall. Several classrooms have been changed into a 240 m2 FabLab : 3 workshops, a lounge area with yellow angle couch and coffee table + full kitchen equipment and dining table, give away area (gratuiterie)
Accompanying and valuing users' practices	Type of collective tasks	Fablab improvement sessions (tidy up, make shelves, mount a milling machine..). Organization of events and training sessions. Participation to outside events to promote the Faclab and the maker culture.
	Type of users contributing to collective tasks	All users (including trainees) contribute to all types of collective tasks in exchange of free access to the Faclab.
	Role of Fabmanagers	Facilitators and prompters. Organize contribution of makers. Contribute to academic curricula.
	form of sociabilities in making	The fact that a maker federates a group of makers around his own project is very seldom. Knowledge and food sharing. Monthly community gatherings.

2017.

Table 3A. Analytical description of sociomaterialities and activities in Faclab in

Name	Casemate	Carrefour numérique2	Le Dôme
City	Grenoble	Paris	Caen

Designing and organising the place	Surroundings	Grenoble is wellknown for its international-grade scientific cluster. La Casemate is located in the fortifications of the City. It is the oldest science center in France.	The Cité des Sciences (worldclass science museum) is located in a cultural complex open to tourists and the working-class neighborhood. The Carrefour numérique has a strong legitimacy in the field of STEAM and digital literacies	Caen is in Normandy. Le Dôme is a new building located in a developing cultural peninsula with a Arts & Media School, a modern music concert hall and a library. It is named after the dome structure on the roof. This unique piece of architecture is considered as the totem of Normandy French Tech.
	Facilities	The Fablab is situated on the second floor with separate access from outside : two red lounge couches and coffee table in the fablab, picnic area with microwave and fridge. On the first floor : staff offices and exhibition area + a biology laboratory. Roof top garden.	A 1000 m2 open lab housed in the basement level of a world-class science museum: a 400 m2 Fablab, several meeting rooms, no kitchen facilities, a couch in the entrance hall	A 3 storey transparent building of 2500 m2 dedicated to open innovation : a Fablab, an open space including lounge and kitchen corners, a showroom, and several meeting rooms. The Fablab is a 300 m2 glass-walled room, on the 2nd floor of the building
Taking care of material devices and artefacts	Technical equipment	laser cutter (2), vinyl cutter, digital milling machine (2), 3D printer (5), 3D scanner, binocular microscope, sewing machine, 36 inch printer	Lase cutter (2), Digital milling machines (3), 3 D Printer ((4), sewing and embroidery machines (3), 3D-scanner, Precision lathe Proxxon PD 400 CNC, Vinyle cutter and printer, Thermal press	Laser cutter (2), Sewing and embroidery machines, 3D printers (2), digital milling machines (2), badge machine, vinyle cutter, equipement for electronics
	participation of users	Golden rules of the Fab Charter	Golden rules of the Fab Charter	Golden rules of the Fab Charter

Accompanying and valuing users' practices	Type of collective tasks	Training sessions (to use the machines) and classes (make a skate board or wooden skis), Documentation. Educational programs.	Visits, training sessions, classes and events (hackathons, drones...)	Collective projects aimed at producing artefacts such as an open source kit for electrically assisted bike. Visits, classes and events.
	Type of users contributing to collective tasks	Residents (the most skilled users called "makers ++" by the fabmanagers) contribute to classes in exchange of reduced membership fees. A former user has been hired to set up a biofablab.	NGOs and Intermediary organizations organise out-of-school programs on digital fabrication and making. Teachers use the Fablab as an education facility.	Residents (organisations) are committed to participating in programming and collective governance. Individuals contributed to the Fablab project and to educational project.
	Role of Fabmanagers	Coordinate educational programs. Participate to logistic tasks when the Fablab hosts events mixing scientists and experts. Hosted one session of the Fabacademy (the former fabmanager is now director ad Fabfoundation). Documentation.	advisory services and technical training for individuals and groups, whether scholar, out-of-school or vocational. Pilot one of the five territorial Resource Centers for digital education.	Coordinate projects aimed at training out-of-school youth. Co-coordinate the local network of Fablabs. Documentation. Pioneer in open badge approach.
	form of sociabilities in making	Designed and run two digital platforms : Echosciences and Fabmanager (including documentation).Open night.	When groups are working, the Fablab remains open to the public. Makers answer questions and are helpful on demand.	Events such as hackathons and Turfu festival. Training sessions. Peer to peer training.

Table 3B. Analytical description of sociomaterialities and activities in La Casemate, Carrefour numérique and Le Dôme in 2017. The participation of users is mentioned in reference to the golden rules in

the Fab Charter i.e. *safety*: not injuring people or damaging machines; *operations*: assisting with cleaning, maintaining, and improving the lab' *knowledge*: contributing to documentation and instruction.

Customizing a Fablab

Our empirical study of Fablabs shows that users constitute a heterogeneous population in terms of age, gender and professional background. The Fablab, as a space, delimits a world for both makers (architects, artists, craftsmen, modelers, designers, graphic designers, etc.), digital hobbyists (hackers, computer scientists and electronics specialist), students (either on their own or with their teachers), journalists, and researchers. It is inhabited by labile material traces of their activities: oil paintings (Net-iki, 2013), three-dimensional materialization of an excerpt from President Barack Obama's address on 3D-printing (Artilect 2013), homemade 3D-printers (Artilect, Nybi.CC 2013), a stabile made of laser cutter leftovers with a picture of each user with his project (Faclab 2013), the prototype of a biking jacket (Faclab 2017), laser cut lamps and dinosaurs (La Casemate 2013), skate boards (La Casemate 2016), etc. When displayed on a shelf at the entrance to the Fablab, they allow visitors to situate the Fablab they are entering as a place of materiality and concrete "things".

The seven Fablabs we studied in 2012-2013 were the initiative of individuals who designed and operated a makerspace to satisfy their individual needs which differed across objectives and situations (Tables 2A and 2B). While Artilect, Net-iki and Nybi.CC can be considered as grassroots initiatives (Smith et al., 2013), Faclab and the three science centers were backed by organizations, and therefore, may appear as top-down initiatives. However, we consider their founders as lead users (von Hippel, 2005) since they were also early adopters of a new socio-technical device in their organizations. Many of the early adopters originate from academia. The founders of Artilect, Net-iki, Nybi.CC and Faclab acknowledged a willingness to concretize their entrepreneurial projects and develop a critical stance towards the national research and innovation system. Some claimed also that they shared the hacker community norms and values. In contrast, the fabmanagers of science centers received grants from the French Ministry of

Research and Education to develop various digital instruments, including two Fablabs and digital equipment for a third one (which was Artilect). They originally mobilized Fablabs in a more instrumental way but the dynamics of the structuration process show that the sociomaterialities of the Fablab progressively reconfigured the organization in each case. The activities of all these early adaptors (Fablab founders, fabmanagers, science explainers, academic staff, science center staff, etc.) include the practice of digital fabrication and making, raising funds, enrolling users, and regulating and managing makers' practices at both the local and global levels. They allowed the construction of the sociomateriality.

Accomplishing boundary work through sociomaterialities

While designing and organizing their Fablabs, early adopters translated and performed institutional actions in managing material devices and artefacts, and accompanying and valuing users' practices. Users also participated in these collective tasks under their supervision. In doing so, they formulated the reasons for the boundary work of institutionalization (Tables 3A and 3B). Reporting on the four Fablabs (which we visited several times over the 3-year period) constitutes a narrative of this boundary work and the institutionalization of making. The Faclab (Table 3A) offers various academic courses related to digital fabrication; the other three are focused on STEAM activities and digital literacy in science centers (Table 3B). All are involved in promoting and organizing changes to practice in the particular Fablab space and its proximity. This boundary work makes visible the sociomateriality through couches, digital machines and electronic supplies, and also articles, websites, conventions, and grant applications, and the artifacts produced and exhibited in the Fablab and/or on its website. Thus, the sociomateriality is both within and outside the physical limits of the Fablab organization.

“The fablab was labeled in summer 2010, by the MIT. Label they relaxed afterwards. There is a list on which people register in a fablab of an Icelandic site and after it is repatriated to the MIT website with the publication of an official list. It is in discussion with the fablab international association which is supposed to govern a little all this.” (Founder, Artilect)

The Faclab can be considered a reference model to study the process of innovation in a sociomateriality since the boundary work is performed by the core team (director and fabmanagers) and the community of users. At the structural level of the organization, the Faclab is a technical platform dedicated to pedagogic innovation, with openness to the public being a pre requisite for the training of students. Access is based on the exchange of knowledge and services to the community (Table 3A). Unlike other Fablabs that have breached the sharing economy rules by introducing a tariff for using the digital machines, there is no reservation system which means that users may have to wait for the machine to be free. Thus, users participate in all kinds of institutional entrepreneurship (Table 3A). The fabmanagers facilitate knowledge exchange between knowers and knowledge seekers, and stimulate participation in collective tasks through regular incentivizing emails to the mailing list. They use this medium also to reprimand members who have abused the shared equipment. Local boundary work is contingent on users’ personal and professional networking. It depends mainly on word of mouth and participation in local public events (Social and solidarity economy week, Sustainable development week). This dynamics is characterized by its slow pace. Although continuity may be impeded, it is firmly anchored in users’ needs. The practice agencies progressively transform the space into an inhabited setting dedicated to making as a shared and distributed purpose. In turn, the community of users is performed and gradually re(configured):

« My mission was fabmanager. It was not clear since I was the first in France. I do not think we ever did a job description. I have to write it. What would I put in? It’s facilitating the word. Roughly speaking, explain the philosophy of the place and put them in touch with those who can help them. We talk to people, we try to know them, to know what they are working with and we are there all the time; And as I have a little memory of faces, it helps. Machines? They turn. Eventually, I taught people to use them, or they learned from other people. » (fabmanager of the Faclab)

The core team of the Faclab has also set boundaries to the institution-to-be, and contributed to establishing a common identity at the national level. On March 3rd, 2013, the Prime Minister officially announced the government roadmap to “foster a national policy on digital development” during his visit to the Faclab. The space had been arranged to make it clear that Fablabs referred not only to technology but also to social practices, and that the network extended across the national territory. Since then, the Faclab has been contributing to the structuring and professionalization of the field mainly through advanced learning programs on Fablab management and digital fabrication. In addition, its former fabmanager has been made President of the French Fablab Network.

The three other Fablabs -La Casemate, Le Carrefour numérique and Le Dôme - share the goals, values and organizational rules and norms of the institution, *Culture scientifique et technique* (Public understanding of sciences), which conveys a diffusionist vision of the relationship between sciences and society. However, they differ in their history and environment (Table 2B). These time and space discrepancies allowed us to analyze the process within the community of makers and at the boundaries of the organizational environment in which it operates. As an example, let us consider the changes we observed during our two visits at La Casemate. In 2013, the staff was learning how to

“do Fablab” as one of them put it. They had assembled a temporary exhibition staging the maker movement and featuring a fully-equipped Fablab with a fabmanager trained in one of the largest and oldest European Fablabs (WAAG, Amsterdam, NL). The exhibition highlighted artefacts produced by local non-governmental organizations and science explainers. Meanwhile, the science explainers were experimenting, seeking a balance between making scientific knowledge more accessible through artefacts produced using the digital machines, and adding this new turnkey instrument to their shared repertoire of interactive resources for visitors. In 2017, the science center had been entirely converted into an open lab (Fablab, living lab and media lab). This spatial transformation had been accompanied by the building of a community of makers and the departure of some of the science explainers who could not adapt to this organizational transition. One of them is now employed full time in the Fablab along with art facilitators but is still under the remit of another department. While the organization has been transformed, the practices of making have also been reconfigured to maintain the boundaries between experts and lay persons through residencies; when they are with scientists, Fabmanagers are confined to logistic tasks (Table 3B). Through the production of OS software and digital platforms for the *Culture scientifique et technique* community, *La Casemate* has also contributed to the global institutionalization of making and transformation of the institution, *Culture scientifique et technique*. The dynamics of sociomaterialities illustrate how the fablab transformed the organization and the institution *Culture scientifique et technique*; the change velocity of the organization, the individuals and the technologies is imprinted in them.

Transforming the surrounding organizations

While contributing to institutional entrepreneurship at the local and global levels, the boundary work in each Fablab contributes to transforming their

backing and surrounding organizations. As a resource for individuals and intermediary organizations, a Fablab may be involved in many different projects. By bringing together different audiences, it allows boundary spanning and redefines the boundaries of the making community. The boundary work differs with the fablabs and their environments. In the Faclab, users’ personal and professional networking slowly blurs the boundaries between the university and community organizations. The comparison of the science centers allows us to characterize further the transformation paces of sociomaterialities. The more the museum is anchored in its territory, the easier it is to institutionalize a new technology as a trusted partner. On the contrary the harder it is to enter a new field. As an example, *La Casemate* brings digital manufacturing in the nearby high schools, and forces the teachers to making instead of using the turnkey education kits they used to provide them by coordinating projects with these partners. But it failed at entering the institutional field of innovation in contrast to *Le Dôme* which missed historical roots as a museum (Malinovskyy et al., 2016). Through residencies, *Le Dôme*’s fabmanagers have achieved cross-pollination and stabilized alliances with the surrounding organizations. The presence of intermediary agents within these partner organizations facilitates the boundary work. As for the *Carrefour numérique* whose users force the backing organization *Cité des Sciences* to move on and invite them to drone conquests, although the fablabs situation (in the basement of the museum) reveals how the museum views it. All these examples illustrate different aspects of how the sociomaterialities of the Fablabs interact with and transform the surrounding organizations.

INSTITUTIONAL ENTREPRENEURSHIP AS A DISTRIBUTED INNOVATION PROCESS

The narrative of Fablab politics in relation to the detailed report “from below” provides an understanding of the different institutionalization layers and organizational textures. We applied the

concept of sociomaterialities to Fablabs to try to understand how the community's search for funding alongside its organizing and sustaining activities led to a distributed institutional entrepreneurship. This is comprised on individuals, technologies/techniques and artifacts, and organizations. In other words, the structuration of the Fablab and its institution in creating a close or more distant environment, are two sides of the same coin. In every Fablab, there is a core team whose mission is to disseminate the maker subculture and hybridize its narratives with those of the surrounding institutions, while preserving the cognitive distance separating the maker and the professional ethos. As a way of structuring the distributed institutional entrepreneurship, the core team progressively tightens (transforms) alliances into formal agreements (projects and residencies). The artifacts produced along the way embody the negotiations between makers' ways of knowing and those defended in institutions, and may either reinforce or impede human and organizational agencies. Thus, institutional entrepreneurship is embedded not only in technologies, but also in the organizational texture of places and the anchoring of projects in an emerging field of related organizations.

Institutionalization of the MIT-CBA model into an institution-to-be, the "French Fablab," has been the result of democratizing innovation (von Hippel, 2005). A substantial part of the literature on distributed innovation focuses on self-organized hacker communities (Elliot, 2006; Heylighen, 2016), innovation by collectives of users with involvement strategies (Hyysalo et al., 2016), and grassroots innovation processes (Smith et al., 2013). Thanks to a better understanding of the role of communities, this renewal of innovation studies stresses the activities of engaged users, expressing a collective and strategic motivation for the politics of their own practice. In the present study, the core team members are the embodiment of these engaged users. Based on their ability to take on the role of leader, they are able to stabilize the institutional framework which is co-constructed in practice. As knowledgeable agents, they have to make

compromises and set priorities when leveraging resources to "create new institutions or to transform existing ones" (Maguire et al., 2004). When adapting their projects to the social and political constraints of a nascent environment, they enable the structuration process and sustain the organizational impetus over time. To benefit from the knowledge of users and creative communities while also protecting the institution-to-be, they develop forms of organization, and management settings which produce a tension with the self-organizing mechanisms that characterize those community. In addition, they develop organizational knowledge i.e. a reflexive consciousness of this agency and the capacity to refer to this agency as a system of practices that they can also manage. Their organizational knowing comes from their regular contribution to the life of the place. In this context, we can refer to Cook and Brown (Cook and Brown, 1999) and Gherardi (Gherardi, 2009) who provide evidence of and investigate these differences in knowledge and knowing in organization theory. Therefore, it is important to understand and recognize the role of these intermediaries among the different institutionalization (local and global) levels, and their ability to adapt the initial model and integrate it into local networks through the process of innovation.

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REFERENCES

Barley, S.R., Tolbert, P.S., 1997. Institutionalization and Structuration: Studying the Links between Action and Institution. *Organ. Stud.* 18, 93–117. <https://doi.org/10.1177/017084069701800106>

- Bosqué, C., Noor, O., Ricard, L., 2014. FabLabs, etc: Les nouveaux lieux de fabrication numérique. Editions Eyrolles.
- Bottollier-Depois, François, Dalle, Bertrand, Eychenne, Fabien, Jacquelin, Anne, Kaplan, Daniel, Nelson, Jean, Routin, Véronique, 2014. Etat des lieux et typologie des ateliers de fabrication numérique – Rapport final. Direction générale des entreprises.
- Broca, S., 2013. Utopie du logiciel libre: du bricolage informatique à la réinvention sociale. Éditions Le Passager clandestin, Neuilly-en-Champagne.
- Cecchini, S., Scott, C., 2003. Can information and communications technology applications contribute to poverty reduction? Lessons from rural India. *Inf. Technol. Dev.* 10, 73–84.
- Cook, S.D., Brown, J.S., 1999. Bridging epistemologies: The generative dance between organizational knowledge and organizational knowing. *Organ. Sci.* 10, 381–400.
- Elliot, M., 2006. Stigmergic collaboration: The evolution of group work. *Mc J.* 9.
- Fligstein, N., 1997. Social skill and institutional theory. *Am. Behav. Sci.* 40, 397–405.
- Gershenfeld, N., 2005. FAB, Basic Books. ed.
- Gherardi, S., 2016. To start practice theorizing anew: The contribution of the concepts of agencement and formativeness. *Organization* 23, 680–698.
- Gherardi, S., 2009. Knowing and learning in practice-based studies: an introduction. *Learn. Organ.* 16, 352–359.
- Gherardi, S., 2000. Practice-based theorizing on learning and knowing in organizations. Sage Publications Sage CA: Thousand Oaks, CA.
- Giddens, A., 1984. The constitution of society. Berkeley U Calif. P.
- Heylighen, F., 2016. Stigmergy as a universal coordination mechanism I: Definition and components. *Cogn. Syst. Res.* 38, 4–13.
- Hyysalo, S., Jensen, T.E., Oudshoorn, N., 2016. The New Production of Users: Changing Innovation Collectives and Involvement Strategies. Routledge.
- Kelty, C.M., 2008. Two bits: the cultural significance of free software, *Experimental futures*. Duke University Press, Durham.
- Kohtala, C., Bosqué, C., 2014. The story of MIT-Fablab Norway: community embedding of peer production.
- Kostakis, V., Niaros, V., Giotitsas, C., 2014. Production and governance in hackerspaces: A manifestation of Commons-based peer production in the physical realm? *Int. J. Cult. Stud.* 1367877913519310.
- Krugh, M., 2014. Joy in Labour: The Politicization of Craft from the Arts and Crafts Movement to Etsy. *Can. Rev. Am. Stud.* 44, 281–301.
<https://doi.org/10.3138/CRAS.2014.506>
- Lawrence, T.B., Winn, M.I., Jennings, P.D., 2001. The temporal dynamics of institutionalization. *Acad. Manage. Rev.* 26, 624–644.
- Leonardi, P.M., 2012. Materiality, sociomateriality, and socio-technical systems: what do these terms mean? How are they related? Do we need them?, in: *Materiality and Organizing: Social Interaction in a Technological World*. Leonardi, Paul M and Nardi, Bonnie A and Kallinikos, Jannis, Oxford (USA).
- Lhoste, E., 2013. Fablabs : de la médiation à l'intermédiation (Mémoire de masters Sociologie de l'entreprise et de l'innovation. Mention : Entreprises, innovations, sociétés). Université de Paris Est Marne-la-Vallée, Champs-sur-Marne.
- Lhoste, É., Barbier, M., 2016. FabLabs. L'institutionnalisation de Tiers-Lieux du « soft

hacking ». *Rev. Anthropol. Connaiss.* 10, 43-69.

Maguire, S., Hardy, C., Lawrence, T.B., 2004. Institutional Entrepreneurship in Emerging Fields: HIV/AIDS Treatment Advocacy in Canada. *Acad. Manage. J.* 47, 657-679.

<https://doi.org/10.2307/20159610>

Malinovskite, M., Mothe, C., Rüling, C.-C., 2016. Aspirations identitaires, complexité institutionnelle et légitimité: Vers l'intermédiation pour l'innovation. *Rev. Fr. Gest.* 42, 169-183.

<https://doi.org/10.3166/rfg.2016.00025>

Maxigas, 2012. Hacklabs and hackerspaces - tracing two genealogies. *J. Peer Prod.* 2.

Mérindol, V., Bouquin, Nadège, Versailles, David, Capdevila, Ignasi, Aubouin, Nicolas, La Chaffotec, Alexandra, Chiovetta, Alexis, Voisin, Thomas, 2016. *Le Livre Blanc des Open Labs. Quelles pratiques? Quels changements en France? ANRT/FutuRIS et PSB/newPIC.*

Meyer, M., 2015. Bricoler le vivant dans des garages: Le virus, le génie et le ministère. *Terrain* 68-83. <https://doi.org/10.4000/terrain.15756>

Orlikowski, W.J., 2007. Sociomaterial Practices: Exploring Technology at Work. *Organ. Stud.* 28, 1435-1448.

<https://doi.org/10.1177/0170840607081138>

Orlikowski, W.J., 1992. The Duality of Technology: Rethinking the Concept of Technology in Organizations. *Organ. Sci.* 3, 398-427.

Orlikowski, W.J., Iacono, C.S., 2000. The Truth is Not Out There: an Enacted View of the "Digital Economy." *Underst. Digit. Econ. Data Tools Res.* 352-380.

Orlikowski, W.J., Scott, S.V., 2008. Sociomateriality: Challenging the Separation of Technology, Work and Organization. *Acad. Manag. Ann.* 2, 433-474.

<https://doi.org/10.1080/19416520802211644>

Rumpala, Y., 2014. Fab labs, makerspaces : entre innovation et émancipation ? *Rev. Int. Léconomie Soc. Recma* 85-97.

Smith, A.G., Hielscher, S., Dickel, S., Soderberg, J., van Oost, E., 2013. Grassroots digital fabrication and makerspaces: Reconfiguring, relocating and recalibrating innovation?

Tracey, P., Phillips, N., Jarvis, O., 2011. Bridging Institutional Entrepreneurship and the Creation of New Organizational Forms: A Multilevel Model. *Organ. Sci.* 22, 60-80.

Troxler, P., 2014. Fab Labs forked: A grassroots insurgency inside the next industrial revolution. *J. Peer Prod.* 5.

Turner, F., 2010. From counterculture to cyberculture: Stewart Brand, the Whole Earth Network, and the rise of digital utopianism. University of Chicago Press.

von Hippel, E., 2005. Democratizing innovation. The MIT Press, Boston (USA).

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