

Open Design, Inclusivity and the Intersections of Making

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ABSTRACT

This paper presents insights from an ethnographic study with a diverse population of *makers* in the city of Newcastle upon Tyne, UK. By engaging individuals, groups and communities who ‘make’ in different contexts, we reveal under-explored perspectives on ‘making’ and highlight points of intersection between different *kinds* of making across the city. We reflect on the dynamics of these intersections and connect our observations to emerging discourses around ‘*open design*’. In doing so, we argue for a renewed focus on ‘inclusivity’ and highlight a need for new infrastructure to support iterative, collaborative making within – and across – interconnected networks of makers.

Author Keywords

Making; Makers; Open Design; Diversity; Inclusivity; Ethnography; Documentary; Participatory Action Research;

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

The popular ‘maker movement’ is often considered to be an exemplar of progressive design values such as openness and collaboration [2, 10, 11, 16]. *Diversity* and *inclusivity* are recurrent themes in the related discourses [1, 17, 23, 38, 43, 60] and ‘*makerspaces*’ (a.k.a. ‘hacker-spaces’, ‘fab-labs’, etc.) often extol these kinds of virtues in their formal manifestos/codes of practice [34]. Indeed, studies of makerspaces have tended to reveal supportive communities of co-operative, like-minded people [61, 63, 64, 65]. Yet to characterize ‘making’ as a unified movement in this way is to oversimplify a complex, multifaceted socio-technical phenomenon [39]. It is to risk overlooking critical nuances in the interactions and intersections between different *kinds* of makers, which might otherwise enrich interaction design work in this area.

There remains a shortage of perspectives from ‘places of making’ beyond the usual makerspaces, hacker spaces and fab-labs. Some notable exceptions include [45] and [61],

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DIS '18, June 9–13, 2018, Hong Kong

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ACM ISBN 978-1-4503-5198-0/18/06.

<https://doi.org/10.1145/3196709.3196718>

but we are still missing insights from places such as home studios, industrial parks and educational facilities, where making takes many forms and reveals (often complex) making practices that complement ‘maker culture’ in interesting ways. Pioneering work by Lindtner et al [44], which has sought to overcome this challenge, concludes, “*we have to take seriously these (alternative) maker practices*”, and there are calls for HCI to be visionary about building links with “*other sites of tech innovation*” [45]. In other words – we need to cast our nets wider.

A good example of why this is important is the *Fab City* movement [21], which envisions cities with distributed, responsive networks of *fab-labs*. This project reflects an intrinsic value of connecting maker networks; the potential for cross-pollinating ideas and sharing resources. However, there is a risk of tension if the project fails to reflect the diversity of existing maker networks. Perspectives from alternative, atypical and peripheral places of making are not always readily apparent, nor are their internal logics, their community interactions or the shape of their interactions with public-facing ‘makerspaces’. In short, our current understanding of the nuanced inter-relationships and complex interactions between different *kinds of makers* in and across online and offline spaces is limited.

This research aims to contribute to an emerging body of work that acknowledges - and is taking steps to overcome - these gaps in our knowledge. In this paper, we present findings from an 8-month study that engaged diverse individuals, groups and communities from the city of Newcastle upon Tyne to explore liminal perspectives on making and points of intersection between different *kinds* of makers. We describe how this was achieved through mixed ethnographic methods (observations, interviews and workshops) and a co-creative, reflexive documentary project, drawing upon participatory action research methods to engage deeply with a diverse cross-section of makers from across the city.

Our contribution is twofold. Firstly, by presenting insights from the peripheries of the maker movement and exploring connections between makers, we are exposing under-researched concerns relating to interactions between different kinds of co-located makers. Secondly, by articulating connections between these concerns and the concept of ‘open design’, we are strengthening links to a highly relevant discourse that relates to both user-centered design and emerging strategies for digital fabrication. We

conclude by advocating ‘open design’ as an agenda for inclusive making within – and across – networks of makers.

BACKGROUND

Interest in making (as a socio-technical phenomenon), and makers (as both users and creators of digital systems) has been growing steadily in HCI for several years [6]. A key point of focus for interaction design research has been self-identifying ‘makers’ (e.g. those in ‘maker spaces’) and the wider movements they align to (e.g. the global ‘maker movement’). Another focal point has been the ways particular groups of users engage with particular ‘maker technologies’ (e.g. *Arduino*). Recent examples include studies with *skateboarders* [28] and *schoolchildren* [48], but such studies have engaged a diverse array of users. The research value of these studies is not in question. However, we are missing some important perspectives. These include people who ‘make’, but resist the ‘maker’ label; businesses who ‘make’, but not with/in makerspaces due to concerns about intellectual property (Hall’s “*2-edged sword*” [33]); private or other non-public groups of ‘makers’ and/or institutions under pressure to be ‘more open’, (e.g. Universities, who balance public engagement with dedicated support for teaching/research) [11]. We have often considered ‘makers’ and ‘non-makers’, but we have tended to overlook *liminal* makers – those on the peripheries of maker culture. These kinds of makers are a sometimes-invisible part of ‘maker culture’ in-practice.

Different Kinds of Makers

The principles of *human-centered* and *user-centered design* remind us that, to design for human users of digital systems (thinking here about ‘makers’), we must seek to understand them. This presents an immediate challenge because the terms we use to refer to ‘makers’ are both varied and flexible. For example, ‘making’ – like ‘hacking’ – can be applied to both digital and non-digital activities. These terms can also be ascribed to people with many different skills, abilities and needs, in many different contexts. Professional ‘makers’, for example, (e.g. industrial designers / mechanical engineers) might be concerned with career-development, profit margins, reputation and the logistics of supply chains and consumer demand in the context of their making practices. Hobbyist ‘makers’ on the other hand (e.g. garden-shed tinkerers / DIY enthusiasts) may be more concerned with the desire to balance personal enjoyment, disposable household income, shed-space, etc. Embracing this ambiguity, we adopt the term ‘maker’, both in our framing of this study and in our engagements with participants. We have done so *because* it is an ambiguous term, and inclusive of other labels (e.g. hacker, tinkerer, craftsperson, fabricator, inventor, engineer, designer, artist, artisan, etc), as well as people who do not self-identify in this way. As a principle of inclusivity, we contend that *anyone* can be a maker ([2] also notes, in a similar vein, “*we are all designers now*” (:53)). For the purposes of this study ‘makers’ are people involved in ‘making’ (the multifaceted socio-technological phenomenon), not just

‘digital making’. In this study, makers include makerspace regulars, university technicians, industrial designers, support workers, administrators, professional engineers, and academic researchers. Our rationale for adopting this approach is that it is *inclusive*; we are interested in exploring interactions between the *different kinds of people involved in making* – not just ‘makerspace’ makers.

Different Kinds of Making

Empirical studies have been revealing of making practices within communities-of-practice, but they have been less revealing about the kinds of interactions *between* communities-of-practice. For example, by studying the interactions of skateboarders and digital fabrication technologies (or, indeed, between schoolchildren and digital fabrication technologies) we gain insights into making that may apply equally to other user-groups as well. However, we do not learn about how a set of shared resources might be used *across* these groups – for example.

A recent shift towards critically re-examining making is taking steps to overcome this by resisting the naïve and utopian thinking that can lead us to idealize makerspace cultures (indeed, [43, 58] explicitly urge caution against “*techno-solutionism*” [49]). An alternative idea within emerging critical discourses – that is now also gaining traction on-the-ground – is to tackle specific challenges with reference to pluralistic values (e.g. care within maker spaces [63]; makers interactions with non-maker communities [62]). This is a pragmatic approach that resonates with similar calls for ‘designing our way out’ of the limitations of neoliberalism [46]. By focusing less on distant ideals – and more on pragmatically *designing our way out* of unsatisfactory realities, *in the direction of* our ideals (e.g. inclusivity) – we have a better chance of contributing to systems of support that will provide a more sustainable route to achieving those ideals.

Our motivation is therefore to hone in on an explicit practical agenda for diverse and inclusive making. This is a particularly urgent challenge. Recent research [44] suggests the “*promises*” of maker culture have the potential to clash with other cultures of making (e.g. Chinese manufacturing) in unproductive ways. We find cautionary tales in similar ideologically-motivated and digitally-enabled domains [50, 42]. The ‘sharing economy’ started as a technological-utopian idea, but has since developed in problematic ways; ‘tragic neighbours’ in *AirBnBs* [22] and tensions between established taxi drivers and users of ridesharing apps. If we want to protect the ideals of the maker movement, which is still characterized by so much goodwill and “*good faith*” [55], we should take steps to pre-emptively address problematic elements in the ‘sharing economies’ of existing ecologies of making.

We are at a point in time where many in HCI (and beyond) are probing the boundaries of what we think of as ‘making’. A recent workshop at CHI’17 [31], built on substantial existing critical mass [25, 26] to explore “*the intersection of*

maker culture and industrial manufacturing". At CHI'16, a papers session, *(Re)understanding Making*, proposed a "critical broadening of maker cultures". Industrial perspectives also validate this critical direction. [37] is a retrospective that celebrates the maker movement's achievements but acknowledges its potential "is greater than its current trajectory" (p30). [20] calls for "a more holistic approach" and a "deeper maker community" (p31).

Recent work by Taylor et al exploring the wider role of makerspaces in public life [61] reflects on how self-identifying makerspaces act as a "third place" (a place away from home and work that plays a key role in public life). Taylor et al's "Community inventor days" (matchmaking 'makers' with members of the wider community) also explored the interactions between makers and wider publics [62]. Now that we know such connections yield value, can existing connections between communities be leveraged in similar ways? What connections exist between maker communities? What can we learn from them and what can we do to help develop them further? A conceptual "maker ecosystem" in [16] (originally in [32]) characterizes relationships between 'zeros' (those "at a loss" with fabrication tools), 'makers' and 'markets'. The unidirectional arrow suggests that (beyond 'gaining new skills' and 'taking an idea to market') the nuances of interactions between makers of different creeds and competencies are proving difficult to articulate (even once we acknowledge, via terms such as "ecosystem", that there *are* nuances in their interactions). A recent study [63] examined a hacker mailing list and identified a variety of subtle social nuances within a single online network of distributed makers. We need to extend this approach to offline and hybrid online/offline contexts as well. We are gradually gaining insights into the varied social roles assumed by makers (e.g. the 'expert amateur' [40]), but there are still many gaps in our understanding.

An open dataset of UK makerspaces [65] focused on self-identifying, public maker spaces. Two are listed in Newcastle but, as our study will show, there are more than twenty (what we call) 'places of making' in the city. Self-identifying, public makerspaces are the tip of the iceberg in Newcastle, as well as other cities such as London [11].

Drawing on our analysis, we have identified a need to explore interactions between individuals, groups and communities of makers and ask: *Who are the liminal, atypical, alternative and peripheral (groups of) makers and what are their points of connection / tension to one another and other makers? What kinds of interactions exist between different kinds of makers?*

STUDY DESIGN

We designed a research study that set out to explore *liminal* perspectives on making and the interactions between different makers in Newcastle upon Tyne (pop. ~ 300,000).

Making in the City

We decided to frame this enquiry within the geographical context of a city for several reasons. First and foremost, the city represents an intermediate position between the *macrocosm* of the global maker movement and the *microcosm* of the individual maker space. It is also a perspective that stands to be especially revealing as global maker movements start to align themselves through concepts such as the *Fab City*. The city also provides a logical focus for a study that is seeking-out complexity since cities are characterized in this way [7]. Perhaps for this reason, studies of making at this scale are rare. Notable exceptions include studies of making from cities in East Asia [e.g. 44] and Northern Europe [e.g. 61]. We felt our small city presented a challenging – yet manageable – scale and, like the previous studies mentioned above, our aim was not to provide a comprehensive account of the entire city. To do so would be resource-intensive and likely obsolesce quickly, as patterns of making change. Rather, our aim was to extend the lines of inquiry beyond the boundaries of one specific group or a single technological intervention.

A key reason for situating the study in Newcastle specifically was its proximity to the researchers. Another key reason was that the lead author is a cross-disciplinary researcher-practitioner with ten years' experience as a 'maker' in this city. The unique perspective this brought to the project informed our research aims by, for example, facilitating the formation of trust relationships with makers across the city. The role assumed by the lead author in this respect is defined in literature on qualitative research methods as an "insider-outsider" [18]. The subjectivity this introduces to the research setting is mitigated by our methodology and accounted for in our analysis; overall, we consider it to be a key strength of the research.

The formal study took place over 8 months and began with a scoping exercise with eight makers in the city with whom we were already acquainted. This took the form of unstructured / semi-structured interviews about general making practices; the kinds of things they as individuals make and how they make them; the other people they interact with in their making practices; the places where they make; the resources they use, etc. This process affirmed the suitability of our methodological approach.

Methodology

Our methodology combines overlapping elements of three qualitative research techniques: (i) documentary, (ii) ethnography and (iii) participatory action research (fig 1). Three ‘hybrid’ methods formed at the intersections of these techniques; each fulfilling a role, either in service to one (or more) of the techniques and/or as a source of additional data. We outline each of the methods / intersections below.

(i) Documentary is a method of generating rich media data within qualitative research [57]. It can also have a further value as a stimulus for dialogue [29]. We used it as a conversation-starter, but we also used the framework of a documentary project to give a logical ‘resolution’ to our engagements with makers, at a fixed time in the future. This enabled highly reflective dialogue with participants, both on- and off-camera as well as constructive conversations about what to film, when and how. Media making activities were concentrated at the end of the project and implemented by the lead researcher. Our approach was not to make a linear documentary; rather, from our participant community, we invited a cross-section of makers to participate in ‘vignettes’ (short films about their social making practices). These ‘vignettes’ all conform to a 3-minute template, so that they can be presented as a (synchronized) ‘video wall’, assembled in an interactive (web-based) documentary. The artistic premise is to highlight similarities between seemingly different makers.

(ii) Ethnography, in this context, refers to our decision to conduct our research ‘in the wild’ using fieldwork methods - observations, conversations and ‘hanging around’ at sites of interest. Our approach was to some extent ‘auto-ethnographic’ [19] (by default) since our ‘insider-outsider’ configuration overcame the ‘initial strangeness’ with participants we were already acquainted with (this applied less as we began to encounter other makers). Our approach was informed by previous HCI work [e.g. 30, 53] that has used similar ethnographic techniques to gain insights into the socio-technical organization of complex communities. We struck a balance between ethnography and documentary by a simple self-imposed rule: visit twice before bringing a camera. To assist in the reflection and cross-referencing of key issues, the lead author kept detailed notes in a notebook/diary over the course of the project.

(iii) Participatory Action Research (PAR) has proven to be an effective technique in numerous HCI contexts [35, 30] as a way of nurturing ethical relationships with research participants, building sustainable collaborations and giving something of-value back to participant communities. In this project, our intention was not to build sustainable collaborations *per se* (although in some cases, this was a by-product). However, we did want to give back something of-value. To achieve this, we actually produced two short films with each participant; one documentary ‘vignette’ (*about* them) and a secondary digital video (edited from the same materials) produced *for-and-with* the participants.

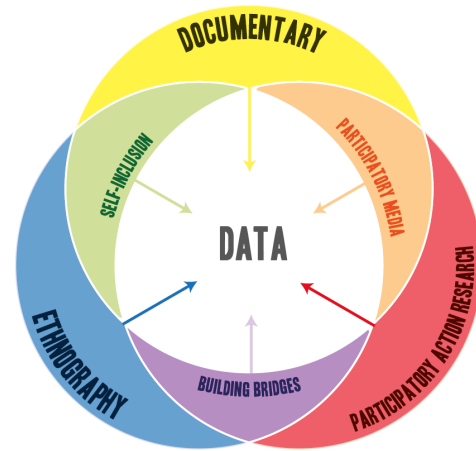


Fig 1 – A visualization of the research methodology. The three points of intersection between PAR, Ethnography and Documentary each generate data.

Intersection 1 - Participatory Media

The short films we made *for-and-with* participants were framed around the participant’s own requirements (e.g. a promotional video for a project, a show-reel, etc.). The short films we made *about* the participant (which we refer to as documentary ‘vignettes’) combined these materials with edited versions of their structured interviews.

Intersection 2 – Building Bridges

We used the opportunity of interacting with lots of different makers in the city to proactively (yet informally) build-bridges between individuals, groups and communities; connecting participants with like-minded makers and sharing opportunities that might be of-value or interest.

Intersection 3 – Self Inclusion

The lead researcher produced a self-reflective documentary about the making of their films – edited to the same template as the others. This was designed to build an empathic rapport with participants and to demonstrate peer-status as a member of the same community (the ‘insider’ half of our insider-outsider role).

Recruitment

To facilitate our aim of engaging makers from alternative, atypical and peripheral places of making, we ‘cast our net’ as widely as possible. To achieve this, we used 8 different recruitment vectors (fig 2). Some of these relied on our acquaintances spreading the word. Others made contact with makers directly - or indirectly - via email, at informal meet-ups/open-days or via events (e.g. *Maker Faire*). Once contact was established, we would arrange to visit their ‘place of making’ and adopt our ethnographic methodology.

The study coincided with a national *Maker Faire* being held in the city. We used this opportunity to experiment with a ‘maker mapping’ activity that invited makers to create custom 3D avatars, place them on a map and use physical threads to create symbolic connections between them (fig 3). The national scale of this activity extends the scope of this paper, but it was an important aspect of our approach that gave us an opportunity to interact with hundreds of

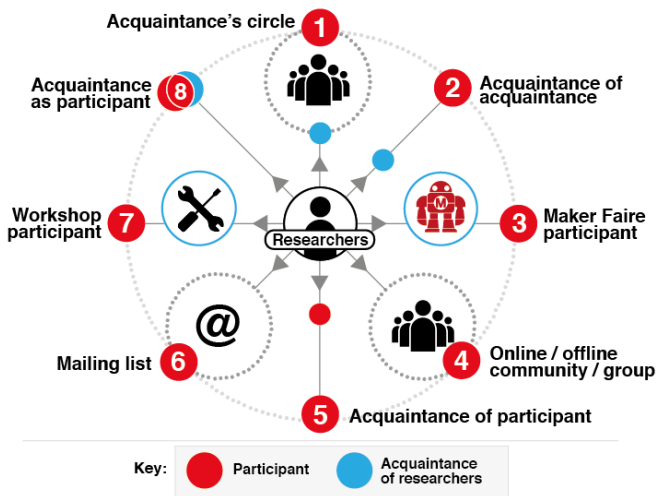


Fig 2 – Participant Recruitment Vectors

makers and engage potential new participants on a face-to-face basis. (We plan to report specifically on the outcomes of this activity in a future publication).

Data Collection & Analysis

We focus our descriptions and analysis on the findings from our ethnographic study. This includes the process of *making* the documentary, but not the final ‘vignettes’ / documentary (We will report on these in another future publication).

In our scoping exercise, we collected 4 hours of audio recordings with 9 participants (5m/4f 23-68), 20-40 minutes each. Thereafter, we engaged a wide variety of makers from across the city. We collected audio recordings, a diary, notes, and engaged with several participants via email, social media and SMS. In all cases, participants were made aware that we were conducting a research project *and* a documentary project, and where we have collected identifiable data (i.e. quotes and correspondence), participants have given written, informed consent for the data to be collected. We have anonymized all of the data collected during our ethnographic study and used pseudonyms for our final group of 11 participants (fig 4).

We used a two-pass thematic analysis to analyse our data. Our first pass was a *deductive* thematic analysis, framed around our aim of identifying liminal perspectives and articulating the interactions between different kinds of makers. Our second pass was an *inductive* thematic analysis that sought to reveal broader issues. The second-pass analysis resulted in themes that we discuss below. As well as monitoring and reflecting upon our data regularly



Fig 3 – Interactive ‘maker mapping’ activity at Maker Faire.

throughout the study, we performed two validity checks at the end of the study. The first was member checking (with a participant from the scoping study, two from the ethnographic study and a documentary participant). Secondly, after our thematic analysis, we scrutinized our data for discrepant evidence and negative cases [47].

FINDINGS

We present our findings in two sections. Section 1, composed of two sub-sections (1a and 1b) derives from the first (*deductive*) pass of our thematic analysis. In (1a) we present descriptions of five selected makers who represent atypical, alternative and peripheral places of making (i.e. those who make outside from the well-known places of making in the city). In (1b) we present the kinds of interactions we observed, highlighting the ‘intra-community’ nature of most of these interactions. Section 2 derives from our second (inductive) pass and contains four themes that suggest wider findings / avenues for further research.

Section (1a) – Makers’ Perspectives

We interacted with over 200 makers, of which a cross-section of eleven (fig 4) participated in the documentary as well. Here we describe five documentary participants in detail (fig 4: highlighted), as examples of *liminal* perspectives on making.

Aaron is a senior technician at a large university. As part of a small team, he manages a rapid prototyping suite that is accessible to over 10,000 staff and students. He facilitates and oversees the safe use of various CNC machines, including 3D printers, laser-cutters and milling machines. Aaron notes a shift in his focus since taking up the role,

“I love making things – that’s how I ended up doing this – now I see myself more as a facilitator. I help people. I don’t really have time to sit and make. I put my time and enthusiasm into helping other people achieve what they want to achieve.”[Aaron]

Aaron acknowledges steep learning curves and adopts a constructionist - “*make mistakes and improve*” - philosophy within his role. His ‘holistic’ perspective on making is also revealing; as an everyday user and regular purchaser / researcher of CNC machines, Aaron reminds his students that they are tools like any other (not prototyping ‘panacea’). He asserts that the best results come from

<i>Aaron</i>	Senior technician, [Anon] University	4
<i>Barney</i>	Founder, Newcastle Makerspace	1
<i>Callum</i>	Academic researcher / designer	8
<i>Daniel</i>	Retired seafarer and amateur carpenter	6
<i>Easter</i>	PhD student	8
<i>Fatima</i>	Self-employed dressmaker	2
<i>Gary</i>	Electronics Engineer / Homebrewer	3
<i>Hanna</i>	Digital artist, [Anon] Projects	7
<i>Ian</i>	Professional Lithographer, [Anon] Editions;	8
<i>Janet</i>	Support manager, [Anon]	5
<i>Karl</i>	Designer / Bicycle mechanic	8

Fig 4 – Participants n=11 (7m/4f)
Numbers correspond to recruitment vector (fig 2)

knowing how to use them alongside traditional tools,

“People think you can just 3D print something and it’s done, but it doesn’t necessarily work like that [...] you use the other [e.g. manual] tools to finish. I think it’s really important to be able to use both sets of tools and not just rely on one or the other.” [Aaron]

Aaron’s point is reflected in both the support-infrastructure and the physical layout of the university workshops; Aaron’s team of fellow technicians work in adjacent, inter-connected workshops, and take responsibility for different facilities; hand tools, soldering stations, band saws, etc.

Daniel is a retired seafarer whose ambition to learn woodworking after his retirement (in 2014) was realized at *Craftworks* after two local carpenters declined his offer of work in exchange for experience. *Craftworks* is part of a charity that provides experiences, knowledge and skills for adults with disabilities and learning difficulties. When Daniel, who is not disabled, encountered the service “by accident”, it had just opened and was not at full capacity so Daniel was given access on an informal, short-term basis. Soon *Craftworks* will reach full capacity and Daniel, who has been using the facility for 2 years, must give up his place. However, during his tenure, having been mentored by *Craftworks*’ manager, he has gained the skills he wanted. Daniel was fortunate to be in ‘the right place at the right time’, but the benefits were also reciprocal; the charity benefitted from Daniel’s informal technical and peer-support to other service-users, which he provided in-kind throughout his tenure.

Fatima is a self-employed dressmaker, who openly prefers to ‘make’ alone and on her own terms.

“It’s not that I don’t work well with other people, because I do, but I have my own ideas about everything and I love working by myself. I prefer working by myself.” [Fatima]

However, she builds close relationships with her customers – whom she describes as “collaborators” – and her practice is co-creative – particularly during the development phases. She also acknowledges a need to draw on others’ expertise,

“... I might have to go to somebody else because I need some equipment that I haven’t got ... [but] ... in terms of collaborating with other makers, they’re mostly kept at a distance. I have a knowledge of who they are, so I can go to them if they can help me in some way, or to work together on small projects.” [Fatima]

Having previously been based in a small city-centre studio (alongside other makers), Fatima now works from home, which benefits her personal circumstances and independent spirit; she also teaches embroidery at a local college, which she describes as,

“...almost like I’m moulding my own little community now because I’m teaching them my ways.” [Fatima]

Hanna is the creative director of ‘AP’, a participatory arts organization based at ‘BH’, a city-centre studio that is also home to various other professional artists and creative businesses. AP is “a platform for collaborations... we put a team together and we do a project”; projects that tend to combine participatory activities, (e.g. “workshops with communities”) with Hanna’s own creative inventions,

“I like combining digital things with physical ones. That implies objects, but also physical spaces like public open spaces, rooms, museums, those kinds of things... [Urban space is] a material; the architecture – the interactions between people – this is a material ... the little details, the way things have been damaged over time” [Hanna]

Hanna is a member of the city Makerspace, but tends to ‘make’ either publicly, in a community setting, or in her own studio (a place littered with breadboards, teapots, wires, IT peripherals, sewing kits, and other esoterica). Her studio is a reflection of her culturally diverse experiences and widely varied interests,

“I used to work in Providence, RI and there was a place called the Steelyard where you could learn to weld (but) it’s difficult in Newcastle to do things with metal.” [Hanna]

Ian is a ‘Tamarind master printer’, “trained in the art of collaborative printmaking”. Ian is fiercely independent; “You try and use what they [The Tamarind Institute] teach you ... but I want to see for myself why things don’t work.” Ian has a well-equipped studio in a creative quarter of the city, where he regularly collaborates with national and international artists on printmaking projects, drawing on informal local connections to hone his craft in innovative ways (e.g. laser-cutting lithographic stones).

“I like using new technology to do something in the hope that at some point it will be useful. I’ll try different things when I’ve got some time and I’ll add it to my arsenal of skills and tools for mark-making to offer to artists - or perhaps myself.” [Ian]

Ian is a busy professional and describes a need to be careful with his time. “I would love to have the time to learn to do lots of things myself – I’m quite hands on – but there’s not enough time in the world.” However, he acknowledges the importance of an active online presence. To balance his desire to connect online with other printmakers and his time limitations, he avoids online printmaking forums except for a “secret Facebook group”, where he shares professional advice with other Tamarind master printers.

Section (1b) – Interactions between Makers

We encountered >25 ‘places of making’ in Newcastle, including the city *Makerspace* (MS), private studios, workshops, ‘men’s sheds’, universities, community centers, charities, industrial estates and home studios. There were a surprisingly large number of CNC facilities, but making and making-related activities (e.g. meet-ups) also took place in various other places; public spaces, pubs and cafes

and private dwellings, as well as online, via social media, etc. We identified numerous overlapping connections between makers with various combinations of ‘*who, what, when, where, why and how*’. ‘*Where*’, for example: Many makers would meet up to ‘make’ together with like-minded makers – not just at MS but at formal and informal ‘places of making’ across the city. Indeed, most of these connections *between* makers took place *within* discreet communities. These typically aligned to a particular *place*, but shared other characteristics such as a social and/or cultural identity (e.g. students, model railway makers, etc).

So, making in Newcastle tends to happen in close-knit communities; however - these communities themselves are fragmented. We now present five examples of such communities and, in each case, outline how they are characterized chiefly by *internal* interactions (rather than interactions with *other* communities). We begin with the city makerspace, and work outwards (fig 5).

Community 1 - Makerspace

Makerspace (MS) is a members-only group, founded and led by Barney. From its launch in 2011 until 2016, MS was based at a street-level shop-front unit in a central, creative district of the city. In 2016, it moved into Studio A, a seven-storey artists studio on the same block. Recently it moved again into the basement of the same building. Several ‘keyholders’ (regulars with keys to the premises) open-up for members on an ad-hoc basis and communication is primarily via an active (public) Googlegroup. They are a sociable, active group who engage with local maker events (e.g. Maker Faire) and collaborate on interactive projects (e.g. kinetic window displays). Nonetheless, its weekly ‘open evenings’ are not usually well attended by non-members. Some participants expressed ambivalent attitudes to MS; “*they’ve got their thing going on and I’m... looking for something different.*”. A common observation was that MS members are mostly male and “*quite a specific age-range*”. It is also perceived to align to a particular stereotype of ‘making’ (“*all microcontrollers and soldering irons*”). MS is an archetypal makerspace; a community-of-practice with a shared interest in microelectronics, digital fabrication, ubiquitous computing, Internet-of-Things technologies (e.g. *Arduino*,

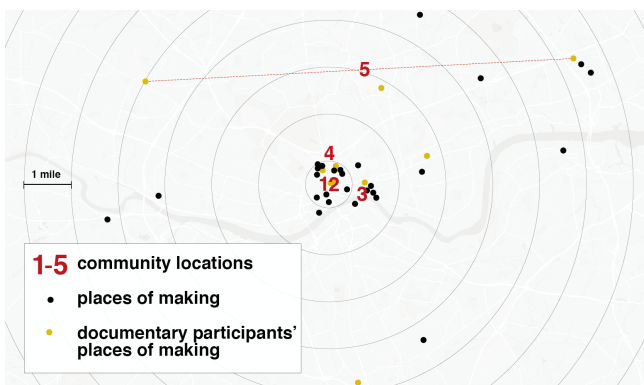


Fig 5 – Approximate relative locations of ‘places of making’ we visited + corresponding communities.

Raspberry Pi, etc) and digital experimentation. It is nonetheless a welcoming, friendly community, who make a regular weekly effort to embrace new members (“*Welcome Wednesdays*”).

Community 2 - Downtown Studios

As well as being home to MS, Studio A is also home to a transient community of (~50) professional creatives (e.g. illustrators, performing artists, musicians, etc.) in individually leased studios. Two floors are managed by *Ampersand*, whose aim is “*to create and manage a multi-functional space that provides a creative and supportive environment for experimental and participatory events, charities and artists.*” BC is a 9-storey studio on the opposite corner of the same block, similarly dedicated to “*the promotion of cross-fertilisation within the arts*”. BC and Studio A are both commercial enterprises and “*friendly rivals*”. Despite participating in public ‘open days’ (e.g. *The Late Shows*), and proactively engaging with other artists in the city (e.g. via the universities), the places of making here (and, by extension, the communities) are not typically ‘open’, nor are they explicitly ‘inclusive’. Two of our participants, Callum and Hanna, have monthly-leased studios at BC. Callum describes the arrangement as follows,

“There is a community of people who have a freelance practice who engage each other as and when they need for the projects that they have, both in terms of work that’s happening locally, but also when people come through Newcastle, when there’s a commission here and they’re seeking local people to produce their work ... there’s a community of people that then support that.” [Callum]

Many in this community rely on public funding, which is increasingly competitive in the UK. The future of this community is therefore uncertain with tenants renting two entire floors of Studio A recently moving out. In the coming months, the ways *Makerspace* will adapt-to (or indeed influence) the community is uncertain. Overall, this is a densely packed network of collaborative artists and makers. Basic, rented ‘places of making’ are affordable and private, yet public and accessible *enough* to sustain and maintain an active – albeit transient - population.

Community 3 - Creative Quarter

CQ is an established hub. It is a sprawling, ex-industrial area that, over the last 15 years, has evolved into a picturesque home to several large independent studios, 3D design practices (e.g. *RSK*), merchants (e.g. *Q-Timber*), charities, a city farm, stables, independent pubs and cafes. It is now a relatively affluent area but it maintains a laid back atmosphere. LStudios (LS) is a suite of 33 studios, primarily occupied by visual artists (including Ian) with traditional making equipment (e.g. Ian’s lithographic press) as well as digital fabrication facilities. Making here tends to be skilled and highly specialized. LS are private studios, but other places (*Q-Timber* and *RSK*) open at street level (the latter, “*a multidisciplinary design and fabrication practice*”, offer “*3D solutions*”, and their fabrication machines are

visible to pedestrians). Ian describes CQ's culture as neighborly and business-like,

"I use local services, who are generally makers themselves. If I need things, I know there are people around I can ask and there's people to help ... There are people around who will give you a hand lifting something, or help you install a new press, or help you move buildings. Some people will be like "we can make that for you" and if my skills transfer, then I'll do that too ... I'm a big fan of the barter system." [Ian]

CQ is a relatively stable cluster of independent makers, who share a strong cultural identity. Interactions are typically social or transactional rather than collaborative. Tenancies are typically long-term and there are strong national and international links to other makers and places of making.

Community 4 - The Universities

The city's two universities have a total of over 60,000 students and staff and their geographical footprint covers most of the city's Northern quarter. Both universities have engineering, art / design, and computer science departments that across the two sites house at least ten different CNC / fabrication facilities. Some are well known and in regular use; others are well-kept secrets (even internally). Some are open access; others are restricted to a few users. Aaron's facility is one of the largest and most widely (internally) accessible of the spaces. The facility used by both Easter and Callum (two laser-cutters and two 3D printers), is relatively exclusive; accessible to a research group with about 100 members, but used regularly by fewer than ten. Both universities use their facilities for teaching and research, as well as to support "third-strand" activities (e.g. consultancy to industry). Many university-affiliated makers (staff and students) have the freedom to use well-equipped fabrication facilities – some even have 24-hour access. As with most universities [8], these facilities are not open to the public, but formal and informal interactions do occur. A formal method is research projects, although these tend to be controlled by and ultimately for the benefit of the university-affiliates who initiate them. An informal method is via social connections to university affiliates. This can lead to informal (or even formal) access, but this unofficial economy remains exclusory to the socially unconnected and it is also open to exploitation. Overall, the two universities are an intersecting pair of stable (yet exclusive) networks, comprising of academics, researchers, students, technicians and engineers. Dedicated access to state-of-the-art fabrication facilities is provided to the affiliated but inaccessible to the majority of the other makers in the city.

Community 5 - The Charity

PCH is an Newcastle-based charity that provides, "a wide range of high quality, specialist and personalised care and education support to disabled people and their families" (a.k.a. 'service-users'). PCH is based on a social enterprise model that integrates commercial services and professional care provision. Facilities are distributed widely across the

city (fig 5) and include *Craftworks* (Daniel's woodworking studio) and *N-Able*, where Janet works as a support manager. Janet is responsible for managing support services across *N-Able's* three co-located facilities; a print studio, a professional kitchen and media-making studios – as well as two remote sites (*Craftworks* and one other). *N-Able* is based at a business park on a large industrial park about 4 miles east of the city centre. The print studio is supervised by Layne, a professional carer with 35 years of experience in the professional printing industry. Layne's primary role is as a carer, but under his supervision, service-users use a variety of (digital and physical) tools to produce flyers for clients in the industrial park and beyond. In a similar arrangement, meals are provided by the kitchen team (service-users, supervised by a chef-turned-professional-carer) and arts events are planned and organized, with promotional media developed in the in-house media studios. As well as being successful commercial enterprises, PCH gives service-users practical experiences of 'making' in a variety of contexts.

"We're in a really fortunate position that we're part of an organisation that has been providing care and support for 65 years. There's a really rich and vibrant culture that comes with that and the people we support really contribute to that." [Janet]

Section 2 – General Findings

2i - Intersecting 'Places of Making' within Communities

In our study, we found clear delineations between community members and non-members in the forms of affiliations and memberships. However, in some cases (*The Universities*, *Downtown Studios* and *Creative Quarter*) multiple unaffiliated co-located 'places of making' shared similar practices, cultures and identities and thus were essentially clustered communities-of-practice. In the case of *The Universities*, despite institutional differences, there were many similarities in the 'making' practices across the two sites; both had similar facilities and networks of professional connections enabled regular interactions between makers across-sites. The main barrier was not individual institutional affiliation, but any institutional affiliation. The *Creative Quarter* and *Downtown Studios*, though operating in very similar ways, were comparatively discreet communities; geographically separated by only 2 miles yet with substantively different cultures of making. *Downtown Studios* nurture a public, collaborative culture whereas *Creative Quarter* nurtures a more private, transactional culture. There are many exceptions, but these cultural differences were widely acknowledged in the wider public as a key distinction between these otherwise similar communities.

2ii - Intersecting Practices within Communities

Each community has its own culture and traditions of making. In each case, this culture co-evolved with practices that are *not making*: trade; education; research; care; artistic co-creation. In most cases, this resulted in potential co-

creativity being hindered by cultural incompatibilities elsewhere. For example, we found several examples of tensions between businesses whose commitments to IPR (intellectual property rights) were ideologically opposed to the openness of (e.g.) the makerspace. Yet, in many cases, a shared interest or goal (e.g. Ian's interactions with RSK relating to laser-etching lithographic stones) would transcend these differences, but only in situations where there were mechanisms in place to assuage cultural incompatibilities (e.g. a bartering economy). There were also imbalances in this regard. It was clear how universities would benefit from interactions with local makers (e.g. student placements) but *quid pro quo* access to high-tech equipment was not always possible. Daniel's experience at *Craftworks* highlights how it can be mutually rewarding to connect makers and service-users (even in a sensitive context), provided the terms are explicit and understood.

2iii - Interrogating 'the' Makerspace

MS's central location and self-identification as a makerspace led many to use it as a point of reference. A consequence of this is that it is often used as a basis for comparison; positive aspects of other places were expressed in terms of provisions or qualities that MS lacks. This was initially flagged in our data as criticism of MS, but we also found many examples of praise and apologetic reasons for not attending, so the error was identified. MS is widely respected, but makers have diverse needs that MS cannot always meet; "*sometimes I want to make things out of metal*" [Ian]; "*I need a big space*" [Karl]; "*...it's just not for me*" [Easter]. Despite a relatively small number of our participants being active members of MS, many had visited; others knew members; some were even members (e.g. Hanna and Karl), but only Barney (its founder) was a regular attendee. A final unforeseen side effect of being the dominant makerspace in the city's imagination relates to university researchers ... "*At Makerspace we get at least one request a month ... most of them thought they would be the first academic making contact.*" [Barney].

2iv - Intersecting Vectors

Earlier, we described several vectors that we used to engage potential participants (fig 2). These represented pathways to makers in communities beyond those we were already affiliated to / associated with. These vectors also the same as those that makers might use to connect with makers beyond their own communities, yet a surprisingly small number of our participants identified with multiple communities. For many, the reason was to do with resources. As one university-affiliated participant said,

"My motivations for joining [a makerspace] would be about the equipment and the space and at the moment, I have both of those things through the university."

There were other reasons as well. For Janet and the PCH community, they are geographically distant from the city centre, but also geographically fragmented *themselves*. Their community is defined by affiliation, professional

objectives and a strong cultural identity rather than co-location. In the case of *N-Able*, they are surrounded by hundreds of 'makers' on an industrial park. Their neighbours make industrial plastics, undersea robots, etc, and have little in common with the kind of making at *N-Able*. Apart from being friendly acquaintances who "*pop to the same shops*" [Janet], that might be the extent of the connection. Yet Janet has pursued this informal vector to pioneer placement opportunities for service-users at several manufacturers from the industrial park. In doing so, she has transcended the community barrier and formalized an informal connection via an opportunistic vector. *Craftworks* is similar - its facilities are adjacent to a bed factory, where service-users gain work experience; making beds and mattresses, using the skills gained at *Craftworks*. The social enterprise model is another vector of a different kind; *what other vectors did we miss?*

DISCUSSION

Our findings confirmed our hypothesis that - even in a small city like Newcastle - there are 'liminal' makers whose perspectives and practices are varied and insightful. We also found evidence of tensions between different *kinds* of makers that result from the fact that 'making' is just one facet of a community's identity. Connecting making can bring other 'facets' (e.g. business models) into conflict, but also potentially into alignment. We found many interesting interactions between makers: Aaron's holistic mentoring, Daniel's opportunistic apprenticeships, Fatima's co-creation with customers, Hanna's creative interactions with people in urban spaces, and Ian's informal bartering with local service providers. These unique interactions highlight the diversity of 'liminal' makers - and the various vectors that can lead them to interact with one another - as well as 'makerspace' makers.

Enabling Co-Creative Making in Cities

Newcastle is a melting pot of co-creativity, both potential and realised. *PCH* are pioneering inclusive, co-creative making. This is partly achieved by being open to informal requests (e.g. to Daniel - and to this research project!) and partly by seizing upon opportunistic encounters with other liminal makers (e.g. in the industrial park). In academic and creative communities, others are transcending community boundaries by similar determination, but usually with limited resources. Co-creative making (therefore) often tends to piggy-back on other (often commercial) ventures, thereby limiting what is possible to the confines of those projects. Bespoke socio-technical support for making *in public* (cf Hanna's public approach to making) might enable more cross-fertilisation among makers and more inter-community making in cities like Newcastle. Makerspaces fulfil a vital role, but they are not a catch-all for active makers in cities.

As we have demonstrated, there can be communities of makers in cities who are unconnected to each other. Projects like *Fab City* risk alienating local makers if they

fail to connect existing ‘places of making’. Two strategies might help avoid this. 1- help connect them to each other directly. 2- connect them via a central node. If we connect them through a central node (e.g. a website), the intervention might *influence* the community. This could be a *positive* influence (like Daniel’s positive influence at *Craftworks*) or it could be a *negative* influence (e.g. like the Universities, who collectively imposed on the makerspace – or, worse, like a nightmare scenario from the ‘sharing economy’; it could result in conflict with existing systems and services). More research is needed, but facilitating multiple direct connections between places of making might be a more sensitive, less risky, and more sustainable approach than a ‘one-size-fits-all’ approach.

Our study suggests the importance of bridging not just makerspaces, but also other ‘places of making’ in cities. We have also highlighted the challenge of bridging clusters of communities. The vectors we used in this project were primarily interpersonal, but other vectors such as social enterprises could inform future research. Indeed, further exploration is certainly needed. The current understanding of existing city networks of making is limited and the intersections between networks of maker communities is under-researched. Other researchers might wish to further explore the tensions and connections at the intersections of making – particularly in other city contexts; especially in the global south, where our knowledge is most limited.

‘Open Design’ as an Agenda for Inclusive Making

In our study, we encountered diverse making practices and makers with diverse needs, including communities of makers who rarely interact with each other. Even collaborative making tends to be with like-minded makers, behind closed doors, or characterized by transactional, goal-oriented interactions that clash with the progressive ambitions for future making. Making in Newcastle is incredibly diverse, yet it remains characterized by subtle forms of *exclusivity*. Of the progressive ideals the maker movement aspires to, diversity rules. This is a paradox: the aim of being both *inclusive* and *diverse* is thwarted by the latter. The majority of the (diverse) making practices we encountered were *exclusive* forms of making (i.e. explicitly *not inclusive*).

The maker movement is defined in-part by its diversity. *Inclusive making* therefore calls for a different strategy; one explicitly aligned to wholly open co-creativity. It must actively resist exclusive elements like ownership, IPR, affiliation - and even notions such as “community”, where one can be ‘in’ or ‘out’.

To develop the digital systems and infrastructure necessary to enable this is a substantial challenge, but it aligns to an existing paradigm of radical inclusivity: “*open design*”. Open design thereby provides an agenda for explicitly *inclusive* making. In a basic sense, open design is a physical analogy of open source software [51]. Yet it extends the basic concept of ‘open source hardware’ by incorporating

two key elements: *iteration* and *inclusion* [13]. It has been defined as the, “*collaborative creation of artefacts by a dispersed group of otherwise unrelated individuals*” [11].

Aligning ‘inclusive making’ to the identity of ‘open design’ could be productive in a number of ways. Firstly, it separates the explicitly progressive notion of *inclusion* from (intentionally or unintentionally) *exclusive* areas of the maker movement. Secondly, it will help the mainstream ‘maker movement’ avoid the problems of ‘sharing economies’ (although to ‘open design’, they remain a key challenge). Thirdly, it provides makers who align to the values of openness and inclusivity a shared identity – thereby providing an impetus, and enriching the maker movement by diversifying it still further. Finally, it opens up an exciting new space for co-design ‘mashup’. As well as constructive, ‘designerly’ input, knowledge-sharing and other traditional forms of contribution, ‘open design’ or ‘inclusive making’ might explicitly seek to nurture iterative public making, perhaps by embracing parody, pastiche - even ‘trolling’ - as legitimate forms of co-creation.

In light of this proposal, an agenda for interaction design is to focus on new ways to facilitate *as many different kinds of maker as possible* to co-create. New forms of support might draw upon those elements we have described; e.g. holistic philosophy, co-creative arts practices, social enterprises, etc. In any case, ‘open design’ is already happening - at the peripheries of the maker movement. If we want to support ‘inclusive’ making, we can look there for inspiration.

CONCLUSION

Enabling co-creativity, particularly at scale, remains a complex socio-technical challenge. Indeed, our study has acknowledged new facets of this challenge through a rich account of a diverse population of makers. Through this, we have exposed a critical tension between ‘inclusivity’ and ‘diversity’ - so much of the culture and practices of making are (gently) *exclusive*. By aligning with ‘open design’, a practical solution space is revealed for digital systems that - via iterative, reflective and distributed co-creation - could enable more *inclusive* cultures of ‘making’ that complement and diversify existing cultures still further.

ACKNOWLEDGEMENTS

This work was funded by the EPSRC ‘Design Your Own Future: Supporting Networked Design Expertise’ Project EP/N005848/1.

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