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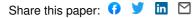**Institutions:** University of Dundee, University of Salford

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Making Community: The Wider Role of Makerspaces in Public Life

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ABSTRACT

Makerspaces—public workshops where makers can share tools and knowledge—are a growing resource for amateurs and professionals alike. While the role of makerspaces in innovation and peer learning is widely discussed, we attempt to look at the wider roles that makerspaces play in public life. Through site visits and interviews at makerspaces and similar facilities across the UK, we have identified additional roles that these spaces play: as social spaces, in supporting wellbeing, by serving the needs of the communities they are located in and by reaching out to excluded groups. Based on these findings, we suggest implications and future directions for both makerspace organisers and community researchers.

Author Keywords

Makerspace; FabLab; making; DIY; community; Men's Shed; wellbeing; inclusion.

ACM Classification Keywords

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

INTRODUCTION

Makerspaces—also referred to variously as hackerspaces and Fab Labs—are one of the most visible manifestations of an emergent maker culture. They provide communal facilities in an openly accessible space, giving access to resources including digital fabrication and open electronics, which have been collectively hailed as enabling a revolution in personal manufacturing. As digital fabrication increasingly enters the public consciousness, makerspaces are dramatically lowering barriers to entry, enabling anyone to create their own solutions to problems or even bring products to market. Initially emerging from universities, makerspaces are now found everywhere from industrial

Figure 1. Typical makerspace facilities. Image © Rory Hyde.

estates to high streets, schools, museums and libraries.

As with most innovations, access to the benefits of makerspace facilities is unevenly spread. Although makerspaces are open to all, many of those making use of these facilities are early adopters with technical or creative backgrounds and a large proportion are affluent males [4]. Many makerspaces have grown out of existing software clubs run by programmers and reflect the demographics of these groups. Our research considers the potential benefits of makerspaces to the broader public and the challenges that might be faced in making this a reality. Initially, our focus had been on the disabled community and how disabled people might make use of makerspaces for their own benefit. While there has been much research focusing on the use of DIY assistive technologies by disabled people [e.g. 8, 13, 14], we sought to understand broader benefits, including wellbeing and entrepreneurship.

However, in surveying existing makerspace usage and outreach activities, we discovered that the potential sources of value to disabled people are in fact sources of value for the wider communities surrounding the facilities. We found evidence that makerspaces have much to offer the communities in which they are located. This is a finding that would not surprise makerspace organisers themselves—for almost all the spaces we surveyed, community engagement was either a core activity or an

aspiration. However, for those working in other community organisations or researching the intersection of technology and community, these findings reveal new resources that cam be harnessed in supporting communities.

In this paper, we report on findings from site visits to makerspaces throughout the UK and interviews with makerspace organisers. For the purposes of our research, we subscribe to the definition of a makerspace as "an open workshop with different tools and equipment, where people can go independently to make something" [31]. These varied between incredibly small spaces that primarily catered to a community of enthusiasts to large spaces providing commercial services. Activity ranged from digital fabrication and traditional crafts to hardware and software hacking. Based on an analysis of the interviews, we describe the different ways in which makerspaces support community beyond those which are most widely known. Building on these experiences, we offer suggestions for makerspaces, communities and researchers on how the value of makerspaces might reach a still wider audience.

BACKGROUND

Maker culture describes a worldwide movement of individuals using a mix of digital fabrication, open hardware, software hacking and traditional crafts to innovate for themselves, underpinned by an ethos of openness and skill sharing rather than commercial benefit [17]. There is a belief that individuals with the right skills can produce solutions that are better and cheaper than mass produced products—or at the very least, they can learn something and have fun while trying to do so.

Much of the focus on making and DIY in HCI has been around individual creativity and craft communities [e.g. 27], but it has also come to be recognised as a potentially democratising revolution for design and manufacturing [33]. Chris Anderson's *Makers* [2] describes a range of examples in which access to rapid prototyping technologies has allowed inventors to rapidly iterate over designs and ship products themselves. This is possible because digital fabrication defies economies of scale, negating the need for mass production to make a product viable. Lindtner et al. [21] pay particular attention to the growth of maker culture in emerging economies, where local innovators can begin to develop their own products rather than simply manufacturing products designed elsewhere. Other examples include hacking and repairing the infrastructure of their environment [1] and empowering technology owners to repair their own devices [28].

Other research has begun to consider the application of digital fabrication and maker culture to wider challenges in society, often aiming to broaden participation in making [e.g. 7, 14, 15, 26]. In particular, a large body of research has explored DIY assistive technologies (DIY-AT). Digital fabrication allows rapid and cheap customisation of existing assistive technologies or even the creation of entirely new solutions [8, 13, 14, 15], aligning with an emerging agenda of designing for user empowerment [18, 25]. For example, E-Nable [9] is a network of makerspaces that are capable of producing 3D printed prosthetic limbs that can be customised according to individual needs—both in terms of functionality and aesthetics.

Alongside the rise of maker cultures has been the appearance of shared spaces where people can come together to share skills, ideas and equipment. The idea of a Fab Lab emerged from MIT's Centre for Bits and Atoms before being replicated in other cities and countries [11]. Fab Labs form part of a global network and sign up to a particular set of shared values—the Fab Charter—that defines them as community spaces, with business as a secondary activity that must not interfere with the primary function. Other spaces, more commonly just referred to as makerspaces, might not be part of this network, although they typically have many of the same facilities and share much of the Fab Lab network's ethos. However, these spaces play a wide range of roles, including co-working space, clubhouse, community centre, school innovation space, museum education centre and shop [19].

Although the dominant focus within HCI has been on "individual makers and their skills" [35], past work has noted that the community within these spaces is often one the most valuable resources they have [21]. Toombs et al. [35] document the implicit and explicit effort required to maintain this community within a makerspace, such as donating equipment, teaching other users, welcoming new members or taking on quasi-official roles within the space. Other research has explored feminist hackerspaces [10], paying particular attention to boundaries defining who does and does not fit within the space's community. Even in these cases, the focus has typically been on the community *within* the makerspace amongst those who could already be considered enthusiasts.

Other fields of study, particularly education and library studies, have been quick to capitalise on the benefits of makerspaces for those outside maker communities [20, 29]. Although the makerspaces in library environments might at first seem at odds, they share a common goal of making resources available to everybody at little or no cost. Usage patterns for libraries have shifted significantly in recent years, offering a broader range of services and sometimes being integrated with delivery of other public services. Makerspace values strongly echo libraries' core mission of providing equal access to knowledge resources [30], so access to digital fabrication has been seen as a natural progression beyond existing ICT provision [5].

The existence of makerspaces in libraries also places them in a space that has traditionally served as a hub of community activity and information. This can be a significant aspect of a makerspace's identity: they are "both a community space and a space for communities" [36], and consequently respond to local factors. Kohtala and Bosqué [16] in particular emphasise the importance of

people and locality in the Fab Lab network, describing how Norway's first Fab Lab responded to the unique characteristics of the community in which it was established, transforming into something quite different to MIT's original Fab Lab. Making is often—arguably always—a political act, as makers aim to intervene to create a world different to the one we live in [24]. Making in communities thus often contains a streak of activism. Barcelona's Ateneu de Fabricació Digital (an *ateneu* is a traditional Catalonian civic space) were intended to allow citizens to take an active role in shaping the city [32]. These spaces recognised that they exist in specific social, political and economic contexts that shape their use. In the case of Barcelona, the facilities opened against a backdrop of economic strife and political dissatisfaction that greatly influenced them [32].

This civic and community facet of makerspaces, recognised by existing work but remaining underexplored, is the focus of our attention in this paper. We focus outwards to consider not just communities of makers who frequent makerspaces, but to the wider environment in which these facilities are sited. We demonstrate a wide range of roles that makerspaces can play in civic life, acting as a hub for both making and other activities, and imparting value in a much broader variety of ways than just the economic potential and hobbyist communities on which past research has focused. In doing this, we begin to see intersections with other topics of HCI research, such as community technology and wellbeing.

STUDY
This paper draws on data collected through a series of site visits and interviews intended to scope out existing activity in UK makerspaces to identify opportunities and challenges in engaging a wider audience. Below, we describe the process of surveying makerspace provision across the UK and analysis to derive common themes of activity. We also provide examples of makerspaces demonstrating typical configurations and community roles.

Data Collection and Analysis
Three members of the research team independently visited a total of 15 makerspaces and similar facilities (the varying self-descriptive terminology reflects differences in origins, provision and philosophy, but all the spaces acted as a publicly accessible workshop supporting something recognisable—but not necessarily identified—as maker culture). Each site visit included a tour of the facilities and a semi-structured interview conducted with makerspace organisers. Question prompts used by the researchers sought information about the history, motivations and ambitions of the facility, its user base, typical activities, promotion and outreach, and specific examples relating to excluded communities. Interviews typically lasted between 30 and 60 minutes and were followed by a tour of the facilities. Most interviews were conducted with a single representative of the makerspace, but in smaller and less

formal spaces, a number of members were present and contributed to the discussion. One Skype interview was also conducted with an arts organisation who worked with profoundly disabled people and had made use of makerspaces, but who did not have their own facilities. Based on an analysis of the collected data, the team derived themes of activity presented in the subsequent sections.

Example Makerspaces
Using a broad definition of makerspaces, our site visits ranged from large commercial spaces to small spaces run by volunteers that identified themselves variously as makerspaces, Fab Labs and hackerspaces, but also facilities that do not identify with maker culture at all. Below, we describe a number of spaces that exemplify different scales, business models and activities observed, and that we will draw heavily on in the following sections.

MAKLab Glasgow
MAKLab in Glasgow is the largest and longest-established makerspace in Scotland and one of the most successful in the UK. Their main space is a highly visible shopfront near the city centre that houses digital fabrication equipment, electronics facilities, a fabric/textiles workshop and an events space. They have a number of other spaces, including a 'dirty' workshop for woodworking equipment and a growing network of smaller, specialist facilities across Scotland, including in museums and libraries. They operate as both a provider of commercial digital fabrication services and a charity aiming to broaden access to these facilities. By comparison to many spaces, they are able to employ a relatively high number of staff, which allows them to invest time in a range of outreach activities.

Dundee Makerspace
Unlike their more commercial counterparts, Dundee Makerspace is one of a number of grassroots facilities started by a small number of enthusiasts with little or no financial support. As is typical of smaller spaces, they do not have formal leadership but rather operate as a collective—although in reality a small number of members play a larger organisational role. They have less capacity for outreach, and while they do run some public events the provision of the space itself for members is their core activity. The space is located in an office building within walking distance of the city centre, which is part of a cluster of buildings housing many of the city's digital and creative sector companies. They rely on membership dues and a small amount of external funding.

FabLab Northern Ireland
The two associated makerspaces located in Belfast and Derry/Londonderry were the first makerspaces in Northern Ireland, but are also notable for the unique political role that they play. Northern Ireland suffered many years of conflict between the 1960s and 1990s, with lingering divisions and sporadic incidents of violence up to the present day. The two Northern Irish facilities were intended to play a part in

the peace process by bringing people together around shared creative activities regardless of their backgrounds. The facilities themselves are located at "interface areas" where nationalist and unionist areas of the city meet and are combined with other community arts facilities, including music studios, practice rooms and other bookable spaces.

Westhill Men's Shed

Westhill Men's Shed (Figure 2) is part of an international movement that originated in Australia in response to concerns about mental health in older men. Like makerspaces, Men's Sheds provide a communal workspace where members can come together to work on their own projects—although the workshops provide traditional wood and metalwork tools rather than digital fabrication equipment. The shed also provides communal areas outside the workshop and like many makerspaces they have expanded their provision into other areas, such as cookery lessons. Attendees are mostly older men who may be feeling isolated following a major life event such as retirement, bereavement or a stroke. The shed provides social contact and a sense of purpose without foregrounding the mental health issues that men may be unwilling to confront explicitly.

FINDINGS

The roles that makerspaces played in their communities fell into four broad themes: acting as social spaces; supporting wellbeing; serving the needs of the communities they are located in; and reaching out to excluded groups. While not exhaustive, these roles presented themselves in almost all of the spaces, manifested in a variety of ways.

A Social Space

Makerspaces are rarely just where fabrication could be carried out. Rather, they are hubs of community, where people come together to work together, learn from each other, or simply socialise. Some of the spaces we visited, such as the Men's Shed, had dedicated communal areas, while others emphasised the value of socialising with others over the machinery itself. Many of the spaces included kitchen facilities and most included at least facilities to make hot drinks—facilities were seen as being just as integral to the space's mission as any digital fabrication equipment.

The smallest of the spaces that we visited, located in a single small office at the top of a tenement building, was most adamant about this point. Identifying themselves as a hackerspace, they were primarily engaged in computer hardware and software. With none of the large pieces of equipment seen in a typical makerspace, the provision of shared equipment was not their main priority, but being in the space had additional value:

> "Most of our members could afford to reproduce the facilities without any issue [...] It's mostly the access to other people that drives them in. You don't really want to be sat in your house all weekend by yourself soldering.

Figure 2. Westhill Men's Shed offers workshop facilities similar to a makerspace, but also prioritises its social spaces. Image © Scottish Men's Sheds Association.

> But if you come here other people might come through and you speak to them and you feel like you're socialising."

This had the effect of turning otherwise solitary activities such as coding into communal activities that could be shared with others. However, this was echoed even by spaces with larger pieces of equipment. In these spaces, the equipment—particularly 3D printers with widespread appeal—were seen as a 'hook' that drew in visitors, who would subsequently stay for the community:

> "Quite a few people who come to the makerspace are interested in microfabrication [sic] and the kind of fabrication boom that's come from 3D printing in recent years. I think the allure of that is something that's got a lot of people on-board, but we all kind of stay for the community aspect and to try help it grow."

Membership-driven spaces typically had at least one open evening per week. Although these were theoretically designed as times when any member of the public could stop by to learn about the space, they had a secondary purpose as designated meeting times for the community. Particularly in the smaller spaces with limited numbers of members, it was at these designated times that the majority of users visited the space and usage outside these times was often very light. Although many regular members had ongoing projects in various stages of completion or planning, these were frequently long-term, tinkering projects (most notably a perpetual motion machine). Instead, we saw members spending much of their time socialising, helping others or just observing members who were actively working on projects, maintaining or tinkering with pieces of shared equipment, or other activities that contributed to the greater good of the space.

In this sense, the smaller spaces had much in common with the Men's Shed. In both cases, the facilities being provided

and even the making being carried out were secondary to the social value that was being gained by sharing the facilities and being connected with fellow makers. At the time of our visit to the Men's Shed, very few of the attendees were engaged in making at all. Rather, most of the attendees were located in the social area, mostly chatting with other members or playing games.

"The big catch is the workshop […] but actually its not about that, it's about health and wellbeing and sociability out there [in the social space]*."*

By comparison, the Men's Shed organiser described another space he had visited that had not succeeded in gaining a critical mass. He saw their key problem as a lack of communal facilities:

"Guy comes in, has a cup of tea, might talk to someone while he makes his cup of tea, does his project and goes home […] you're telling them its not available to socialise, there's no possibility for that."

Many of the spaces were also self-organising, grassroots initiatives, typically started by friends or an existing group, such as a software club. They had little in the way of organisational structures, and what structures they had often existed only for legal purposes so that they could be registered as a social enterprise (a business with a social mission that reinvests profits in itself). In one case, the contact person for a space reacted sharply to an email request to speak with the space's organisers, as the idea of a hierarchy conflicted with strongly-held values:

"There are directors because there have to be directors. There's nobody organising anything. It's very different from the way [other] *makerspaces are probably structured as […] companies and arts organisations. We just want to have the space."*

This space represented one extreme on a spectrum: in reality, most of the grassroots spaces had a small group of founders and core members who took it upon themselves to keep the space open by applying for funding, maintaining equipment and acting as a public face for new members.

However, the social qualities of makerspaces were less apparent in the larger, more commercial spaces. Although there were normally tables where people could work and sometimes kitchen facilities, there were no apparent regular events or core members outside the staff. Owing to their larger size and organisational needs, there were also more defined hierarchies and they were often created by partnerships between local councils, arts organisations or knowledge institutions rather than emerging in a grassroots fashion. These spaces did have other roles in the community, as we will discuss in subsequent sections.

Serving Local Needs
While the makerspaces were broadly similar in their equipment and ethos, we were struck by the subtler diversity in their activities and goals. Makerspaces very much served the communities in which they were located, responding to local needs and issues and tailoring their provision accordingly, much as the Fab Lab model was customised as it moved from a North American university to the Norwegian countryside [16]. One of the makerspace organisers spoke explicitly about the effort that they put into this:

"We've had to work hard to make this relevant […] there's a utility to what we do, it's useful in some way rather than just proving the concept."

One way in which makerspaces responded to the local community was in catering to industry and employment needs. Most literally, many of the spaces had helped local industry to create custom parts—in one case a police forensics team wanted to build a DIY alternative to an expensive piece of equipment. More broadly, it was common for spaces to have a training programme, some of which were accredited and recognised (e.g. OCN Level 1 in Digital Fabrication). Even where formal training was not provided, they still saw the skills being developed—both by young people and those retraining—as being useful for a future career in industry:

"It's a good way to […] start thinking about a creative career or an engineering career […] you can use the FabLab as a platform to find jobs and get experience."

This makerspace was able to identify several examples of users who had gained apprenticeships either directly or indirectly through their experience, and was now offering its own apprenticeships. A number of spaces also took on young, unemployed people in work experience roles. This trend was particularly visible in spaces located in industrial cities and towns or where unemployment rates are high. In one case, the entire makerspace was funded by the nuclear industry, which was a major employer in the local area. Although this was partly a goodwill activity, it also served to develop skills and an enthusiasm towards science and technology in local young people that would be useful to a future career in the energy sector.

However, the economic contribution was not entirely industry-focused. In one example, a makerspace in a small town had enabled a local café to create unique decor that was a defining feature of the business. For the café owner, this had a double impact, enabling her to keep costs down when starting her business, but also making her venue unique—visitors would frequently comment on the decor and such comments also featured heavily in TripAdvisor reviews:

"Every room in the bistro has got at least one item that was created by the FabLab. They played a very big part in the making of the decor and the atmosphere […] people love it […] they say it's more of a big city style."

For the Men's Shed, taking on jobs from the local community was a core part of their business model,

alongside upcycling tools and equipment. Small jobs received were posted on a jobs board, where members could choose to take them on. Typical jobs included building benches and mailboxes for clients ranging from private individuals to schools and local government. By taking on these tasks, they were not only able to provide value to the local community, but also perpetuate the space, effectively reinvesting the funds into the community:

"Last year the guys did thirty-two community projects which they charged for […] *they're completely self-sufficient after a year and a half."*

However, they were careful to do this without undermining local businesses:

"The projects that they do are pretty much projects that people don't want, that charities and schools can't afford […] *and they know that their fathers and grandfathers are benefiting from* [doing the work]*."*

The Men's Shed emphasised that jobs should come without stress and deadlines, which would interfere with the space's core mental health goals.

Meeting local needs did not only take the form of service provision benefits. One of the most striking examples of makerspaces responding to local issues was in the Northern Irish FabLabs. The Belfast FabLab was located in the north of the city, which—in addition to being an interface area between nationalist and unionist neighbourhoods—was one of the most socially and economically deprived areas of the city. Part of their mission was to bring together people from both sides of the Northern Ireland conflict around shared, constructive tasks and activities that helped to develop skills and economic prosperity:

"We're moving into […] *having a focus on social enterprise and social innovation, partly because we believe that those two elements are ways of normalising post-conflict society* […] *if people feel that they have a future and they play a part in that future then you're offering hope and you're more likely to take the tension out of divided communities."*

Their sister site in Derry/Londonderry likewise engaged in civically engaged making as part of David Best's *Temple* (Figure 3), a crowdfunded installation built in 2015 [6]. Over a week, the 22-meter wooden temple was visited by 60,000 visitors, who were encouraged to attach a memory to the structure, leaving it behind and symbolically letting go. At the end of a week, the entire temple was burned in front of an audience of 15,000 people. The city's FabLab contributed a series of ornate panels made by young people, who completed the work as part of a training course. Other community groups helped to build lanterns that were used during the burning of the installation. In this example, we see the entire city being engaged in a collaborative act of making that cumulated in the creation of a substantial artwork with ambitions to have an impact on societal issues

Figure 3. Inside David Best's *Temple*, Derry/Londonderry. Panels were covered with personal messages before the structure was burned. Image © Kenneth Allen

affecting the city. Although the FabLab itself played a tangential role, it was nonetheless able to harness enthusiasm around making to deliver training to young people—thereby contributing to efforts around both reconciliation with the past and development for the future.

Wellbeing and Empowerment

For most of the makerspaces, wellbeing was not an explicit goal, but nevertheless manifested itself in a number of ways. The idea of craft and other creative endeavours as an activity for wellbeing is not a new one or one that is exclusive to makerspaces [37]—as part of our study, we interviewed one disabled arts organisation who have spent the past 20 years working on long-term arts projects with profoundly disabled people. For them, there was little doubt that both the act of making was highly beneficial:

"You get lost in a process […] *what happens as a result of making means a lot."*

Due to the overall focus of our project on disability in makerspaces, many of the wellbeing activities identified in interviews related to this. As documented by existing research, assistive technologies were an obvious use case, and one of the spaces had recently printed its first prosthetic limb. However, for many users of makerspaces, the wellbeing aspect of the facilities is not about solving particular problems, but about the simple joy of making something. A common sentiment expressed was that *what* was made didn't matter, but rather *how*—the act of making itself was more important. In most cases, disabled users were not building anything that related to their disability. Rather, the benefit was in being in a space that empowered them to be creative:

"It would be more about bringing them into a creative space and doing things […] *the technology takes away some of the barriers."*

"I was surprised by it […] *what that does for people, how they feel liberated."*

For others, makerspaces presented an opportunity to develop skills and to engage with the world in a productive way. Inspiring examples from our interviews included a teenager who had not left his home for six months prior to visiting the makerspace, but who was able to engage with other people his own age and publically reach out to the makerspace on social media to thank them for the experience. At another space, one of the volunteers was in rehabilitation from an unspecified condition: his volunteer position allowed him to build confidence and skills—not just in terms of utilising machinery, but also in engaging with members of the public.

"It's a way for him to engage with the public again, where he didn't have the confidence before, and so he's learning how to use the machinery, but at the same time he's building skills that he could use to get a job once he's fully rehabilitated."

Many of the examples fitting this theme included similar individuals who had difficulty interacting with others for varying reasons—reports of makerspace users with autism arose in a large proportion of the interviews, for example. This highlights the importance of providing the form of social space described previously.

While most makerspaces do not actively aim to achieve wellbeing outcomes, the Men's Shed made it central to their existence—even if it wasn't foregrounded. The Men's Shed that we visited formed part of a worldwide movement that originated in Australia in response to mental health issues amongst men and their unwillingness to seek help. This was particularly acute amongst retired men, whose identity and social circles may have been closely tied to their jobs. Men's Sheds directly address loneliness in this population, but also provide a space with less perceived stigma attached than traditional wellbeing provisions, in which men may eventually feel able to address other issues affecting them. This movement has been replicated in many other countries, including Scotland, where a single pilot shed started by a council worker has subsequently grown into a nationwide network.

Wellbeing benefits were readily apparent during the site visit. For example, several stroke victims who lived alone were visiting the social space to practice speaking. Another attendee, a World War II veteran in his 90s, repeatedly remarked how the space had given him a new lease of life following his retirement and the subsequent death of his wife. He had learned new woodworking skills and now made wooden chairs and benches, some of which had been commissioned for public spaces in the local area (as described in the previous section). In addition to 'making' in the sense of wood and metal, the Shed also ran cooking lessons targeted at helping widowers to become more independent and improve their health. The fact that this took place in a safe environment alongside activities perceived as being more 'masculine' allowed them to reach those who—as with mental health—might not be willing to access other provisions.

The wellbeing outcomes were remarkable: a social return on investment analysis showed a tenfold return in terms of reductions in loneliness and reliance on public health services and other forms of support. Members were happier and more active, in some cases leading to physical health benefits and reduced reliance on medication—the organiser cited research findings that loneliness alone has the same health impact as 15 cigarettes a day [12]. It also provides a place where consumption of alcohol is not possible in an area and population with high levels of alcoholism. Health research in Australia has confirmed these outcomes in some of the original Men's Sheds [3]. At both the Men's Shed and the other examples provided, making is a hook that brings people together and places those with different wellbeing needs on a similar footing around a shared activity.

Widening Access
Almost all of the makerspaces were engaged in some form of outreach, most commonly by running workshops with members of the public who might not normally engage with making. These sometimes included bringing external groups into the makerspace, but often involved taking equipment out of the makerspace, either to public events or to particular groups of users such as schools. The importance placed on reaching a wider audience was evident even in the way spaces described their objectives:

"Make digital technologies and software as available to as wide a range of the public as possible at as low cost as possible."

"Enabling everyone to create anything."

Even in the smallest of spaces, there was an expressed desire to be more inclusive. Organisers cared greatly about openness and accessibility, and were often frustrated with their inability to meet these needs. For example, the smallest space was located in a cramped office with no elevator, but their funds were insufficient to allow them to move elsewhere:

"We've tried [to move] *twice, but we struggle to maintain a positive balance* […] *it's unfair to block off a resource like this."*

For some makerspaces, being able to secure a premium location on the high street, typically with the backing of local authorities, was seen as a core method of reaching a wider audience:

"We get everybody […] *they walk past and they stick their head in the door and they say 'what's this all about?'"*

Figure 4. Workshops with members of the public engage a wider audience who might not otherwise access makerspaces. Image © Mitch Altman.

But for all types and size of space, dedicated public events (e.g. Figure 4) both inside and outside their own facilities were the most common form of outreach. Broadly speaking, these events were intended to introduce attendees to the possibilities of digital fabrication, usually through a small, structured task that resulted in a tangible outcome. These were generally intended to act as an inspiration and starting point for people who want to do more, especially for school children:

"We do after school clubs for kids […] *people who've completed that* […] *they go away and sit on their own or in groups and come up with their own ideas."*

Although this might be seen as a natural avenue for recruitment, organisers reported mixed successes in converting attendees at outreach events into regular users of the facilities. For larger spaces with varied income streams, this is not a problem, but for membership driven spaces, growing their subscribers was necessary to achieve their ambitions. Rather, these spaces reported that recruitment was often by word of mouth, which presents greater challenges in reaching outside typical demographics.

In responding to the demands of their community, some of the spaces were broadening their provision beyond the most commonly found digital fabrication and electronics equipment. For example, one of the makerspaces has recently added a textiles workshop with professional sewing equipment and, at the time of writing, are advertising an introductory course to domestic sewing machines. This had brought in a different audience, but has encouraged learning and collaboration between different communities of interest:

"It's bringing in a different type of user, at the same time they're then feeding back into [other activities…] *you're getting a different sort of overlap, just broadening again the range of users, that maybe they wouldn't normally have come to this sort of space before."*

Like 3D printing, these activities might be considered as 'hooks' that draw in people with varying interests who might subsequently branch out to explore other materials and processes, or take advantage of the social benefits of makerspace usage described previously.

However, despite the best intentions of the makerspaces, it was availability of resources, particularly staff, that was the primary factor in determining the level of outreach activities they were capable of conducting. In this area, there was a marked difference between small grassroots makerspaces and larger commercial facilities—larger spaces had more staff, but they were also able to reinvest income from commercial work to support the charitable and outreach aspects of the space's ambitions.

"We don't have any employees. There's nobody to do it. There's nobody trained to work with any sort of people."

"Whatever activities we have here, more commercial enterprises […] *all that money then goes back into funding outreach programmes."*

At the same time, the fact that most makerspace users are there to engage with things they are passionate about can be a boon when this intersects with outreach. For example, one of the full-time staff members we interviewed had a background in caring for people with mental health problems. This background manifested itself in the organisations the space chose to work with, the types of activity that they organised, and in her acute awareness of accessibility issues. Conversely, even in those spaces that had resources to conduct outreach activities, staff and volunteers were cautiously enthusiastic, but aware of their own lack of skills in dealing with people who might need extra consideration, particularly when resources did not extend to additional training or facilities:

"We are not trained for work with disabled people. I'm more worried about that. But I'd see it like a challenge […] *I'd like to do it just to see how."*

Finally, some factors influencing outreach are more culturally ingrained. For example, for some new users, the ability to create anything was intimidating and some makerspaces discussed using designers as facilitators for inspiration. But there were more varied reasons for exclusion, even amongst those who might otherwise want to use the facilities. For various segments of society, there might be a feeling that they simply don't 'fit in'. In one example, a child was unable to return to the makerspace due to his parents' feelings of exclusion:

"One of the young gentlemen who was involved from the school [said his parents] *don't speak English. They felt very much like they couldn't come in, that it wasn't for them, no matter how much we talked to him."*

Although public events and the increasing public awareness of digital fabrication—particularly through its presence in schools—might help to ease this, most makerspaces are in

their infancy and clearly some way from meeting their ambitions of being truly accessible to everybody. This last point in particular speaks of deeper inclusion issues that makerspaces share with other public resources, where exclusion is not just about access to technology or facilities, but a more fundamental exclusion from large parts of society.

DISCUSSION
Through a survey of 15 makerspaces, we have identified a number of broad themes describing ways in which these resources support public life. These impacts are much broader than just those that are commonly reported on, having implications for wellbeing, social life, local communities and potentially reaching a wide audience. In identifying these wider impacts, we begin see overlaps with other areas of HCI research, such as the role of technology in community and in supporting wellbeing. Below, we reframe the wider civic role of makerspaces in terms familiar to HCI and describe a number of remaining areas of potential that HCI researchers may be well-equipped to support makerspaces in exploiting.

Makerspaces as Third Places
Throughout our survey, we saw many spaces that matched the image of a makerspace held in popular imagination: stylishly utilitarian rooms filled with exciting equipment and brimming with ideas. But we also saw spaces being shared with museums, galleries and games companies, and utilised for events that ranged from Robot Wars to hairdressing lessons. It is clear, then, that makerspaces are not just homes for 3D printers and laser cutters. Rather, they are public resources dedicated to creativity, learning and openness. This comes at a time when many communities do not have a community spaces and where civic life is often seen as being in decline.

A number of scholars have already argued that makerspaces are effectives effectively *third places* [22, 34]. The notion of third places—social spaces separate from the home and workplace that play a critical role in public life [23]—has been a popular one in HCI, but some of the critical features of Ray Oldenburg's term have tended to be disregarded. His third places were homes away from home that acted as social levellers, places where one can find both regulars and friends old and new, places that never became overly serious. Almost all of these properties are embodied by makerspaces. Perhaps the only aspect where they do not align is in being accessible to all, where the ideals held by makerspaces are not always achieved, despite best intentions. Regardless, viewing makerspaces in this way gives us a starting point for understanding the role that they might play in communities, and learning from other research around third places might provide indications of further possible sources of value to communities.

Playing an Active Role
As we have shown, makerspaces play various roles in public life and have been very successful in that role. Despite this, we were struck by how few of the spaces had an explicit agenda beyond making digital fabrication equipment available to as many people as possible. Indeed, some of the spaces actively rejected any notion of a further agenda. However, where there was an agenda—such as wellbeing in the Men's Shed or reconciliation in Northern Ireland—the makerspaces had been able to make a remarkable difference in their communities. The success of these ventures causes us to reflect on whether makerspaces should be encouraged to take a more active stance on creating positive change, despite the inherent tension that this introduces.

One way in which this tension might be resolved is through a more concerted effort to connect makerspaces with those who *do* have agendas. On the whole, even those makers who did not want to push an agenda for their space remained enthusiastic about tackling problems brought through the door by visitors. Providing a challenge, especially in an area that makers aren't familiar with but are keen to engage with, can be highly motivating. This might mean connecting makers with local communities, national campaigns or even international networks. One area where we can see this happening is in the E-Nable community of makerspaces who offer to work with disabled people to produce prosthetic limbs. Issues remain, particularly the risk that makerspaces might be put under pressure to deliver, where they see themselves as hobbyists—"no deadlines, no stress", as one organiser put it. However, opening these channels of communication presents opportunities for both makerspaces and communities.

Making the Case for Makerspaces
Over the course of our research, we have been struck by the difficulty that makerspace organisers had in identifying and highlighting concrete examples of positive outcomes for makerspace users. This included not only the intangible social benefits that we have focused our attention on here, but also the more widely discussed economic benefits. One organiser spoke openly about their inability to track outcomes and the difficulties that this created—even pondering how they could be sure that the effort put into maintaining the space was worthwhile. To a certain extent, this is a reflection of the freedom that members had to access equipment independently and also the lack of central coordination in the smaller spaces. Organisers were enthusiastic makers, not administrators, whose primary focus was on making the resource available.

However, being able to communicate these outcomes is important in securing the future of this resource, especially against a backdrop of funding cuts. For example, being able to calculate a social return on investment and identify intangible benefits to the local area allowed the Men's Shed to gain support from local authorities and propagate

quickly. Although there have been some efforts to document the extent of makerspaces [e.g. 31], the sheer variety of scale and activity makes it difficult to grasp their social and economic impacts. If makerspaces are to be sustainable and to play a role in communities akin to libraries—which appears to be a reasonable goal for at least a subset of the facilities—then it will be necessary to communicate their benefits more effectively.

CONCLUSION

In this paper, we have discussed a variety of roles that makerspaces play in civic life, which extend far beyond those roles they are most commonly associated with. These roles speak of huge potential for makerspaces to benefit communities and individuals. While not all of the roles we have observed are present in all makerspaces—this is to be expected given how responsive many of the spaces are to the particular needs of their communities—the desire to be more than just a workshop is widespread.

It is clear that makerspaces should be seen not as a gimmick or just the preserve of technologists, but taken seriously as a resource for communities. However, barriers remain that must be addressed if this potential is to be reached. In particular, future work might focus on the barriers that prevent individuals who might otherwise be interested in utilising the spaces from doing so. While the motivations of makerspace users have been documented previously, non-use is a more complex issue that deserves further attention.

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