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The Maker movement and its impact in the fight against COVID-19

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The Maker movement and its impact in the fight against COVID-19

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Abstract

This study is an initial attempt to document the impact of the Maker movement in addressing the spread and prevention of COVID-19. During the early stages of 2020, extreme shortages of critical items led to an unprecedented global mobilisation of grassroots, community-driven Maker projects. The first part of this study reports on efforts to document Maker projects to tackle COVID-19 between March - June 2020. It analyses the characteristics of 158 projects with respect to project type, geographical region, manufacturing technologies and type of actor involved. The second part of the study provides a more detailed perspective of the challenges that Makers faced during this period, by looking at the UK case. It adopts a digital ethnographic approach, analysing a web-seminar organised and hosted by the authors in collaboration with Make:, one of the most widespread online communities of the Maker movement. The web-seminar took the form of a panel talk and discussion with representatives from four prominent COVID-19 Maker projects in the UK. This study reports on several cross-cutting themes that emerged in the panel talk. To maximise the potential impact of the Maker movement in a crisis, the findings call for: the development of a national network of Makers in the UK that is supported by policy and governance; the creation of a centralised database to manage demand and supply of critical items in times of crisis; and advancements to management of distributed quality control. This paper helps to document the impact of the Maker movement during the COVID-19 pandemic. It also underlines the potential impact of the Maker movement in addressing future crises via the development of distributed innovation actors.

Keywords

Maker movement, makers, digital fabrication, COVID-19, pandemic, crisis, grassroots innovation, crisis critical products

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1. Introduction

On 5th January 2020, the World Health Organisation (WHO) issued its first statement on "pneumonia of an unknown cause" (WHO, 2020a), and COVID-19 was subsequently declared a pandemic on 11th March 2020 (WHO, 2020b). The rapid and global spread of COVID-19 during the start of the year led to sudden shortages in critical items, including ventilators, Personal Protective Equipment (PPE) and testing equipment. As images of overwhelmed hospitals began to circulate (BBC, 2020) and reports of shortages became more widespread (Merrick, 2020), grassroots and community-driven efforts emerged to develop items to tackle the spread and treatment of COVID-19. Early reports of Makers in Italy using 3D printing to produce urgently needed spare parts for ventilators received widespread acclaim and captured the imagination of the Maker community (Sher, 2020). In the following weeks and months, an unprecedented number of Open Hardware projects were developed by Makers around the world.

This study seeks to document the impact of the Maker movement during the early stages of the COVID-19 pandemic. The authors were initially motivated by the desire to create a centralised database of Maker initiatives responding to COVID-19 in order to help improve knowledge sharing. As traditional supply chains began to recover in June 2020, the active tracking of new Maker projects was paused. The study was then complemented by including and interrogating the voice of Makers in the UK who were actively involved in developing COVID-19 projects, in order to identify the perceived drivers and barriers of working in a crisis.

This paper is structured in the following parts. First, we introduce the emergence of the Maker movement, as well as outlining how Makers have played a role in crises to date. Second, we present our methods, providing a detailed description of how we documented Maker initiatives responding to COVID-19. Third, we show the results of our efforts to map the global Maker response to COVID-19, before providing an in-depth analysis of the UK Maker landscape. Finally, we conclude by identifying key recommendations for how community-based Maker projects can be more effectively organised in future crisis-scenarios.

2. The emergence of the Maker movement

2.1 Digital fabrication tools

The increased availability and affordability of digital fabrication tools (e.g. 3D printing, laser cutting) has meant that for the first time "non-specialist" individuals can access production processes that were only previously available by industry (Langley et al., 2017). The proliferation of digital fabrication, as well as related digital tools and infrastructure, have made it possible for geographically dispersed actors to collaborate using common design files

(Rayna et al., 2015). Digital fabrication projects started in one place can potentially be shared with and implemented by others around the world (Anderson, 2012). Hence, the very nature of these technologies allows designers to collaborate and co-design with others, regardless of their geographic location.

In the past decade, digital fabrication tools have gathered the attention of the so-called peer-production generation (Menichinelli, 2015), otherwise known as the common-based peer production generation (Troxler, 2010) or simply the Maker Movement (Dougherty, 2012). These denominations all refer to a growing community of people which values and promotes a DIY (do-it-yourself) mindset and engages in a wide range of activities, including hardware and technology projects (Peppler and Bender, 2013). One hallmark of the social system that underpins this community is its cooperating and sharing ethos (Lang, 2013) which encourages members to share both tangible (e.g. tools, spaces, machines) and intangible resources (e.g. knowledge, time, contacts) locally, in physical workshops and globally, through online platforms.

2.2 The rise of local fabrication spaces

Digital fabrication tools are becoming increasingly available thanks to the emergence of fabrication spaces like makerspaces, FabLabs and Hackerspaces. These are open design and fabrication workshops that offer a wide range of rapid prototyping equipment such as 3D printers, laser cutters, milling machines, wood and metalworking machineries, just to mention a few, as well as courses that enable non-specialist individuals to acquire the knowledge to design, develop and prototype new products using such equipment. These workshops are "locally implemented but globally connected" (Menichelli, 2015) with the broader Maker community both online, on social media platforms or on specialised platforms for design sharing (Rayna et al., 2015), as well as physically, at dedicated off-site gatherings like Maker Faires (Dougherty, 2012).

One of the first examples of a Fabrication Space was launched at the MIT's Centre for Bits and Atoms in 2002 as an educational endeavour (Walter-Herrmann, and Büching, 2014). Since then, these shared machine workshops have been spreading fast and constantly evolving to adapt to the needs of their local context. Their number keeps increasing. At the time of writing, there are over 2000 fabrication spaces in over 100 countries (FabLabs, 2020).

2.3 The Maker movement in a crisis

The increased availability of digital fabrication has significantly lowered the financial and human capital necessary for individuals to engage in the production process (Browder et al., 2017). This democratisation in production has led to a so-called democratisation of innovation

(Walter-Herrmann & Büching, 2014), widening the sources of innovation (Browder et al., 2017; Mortara and Parisot, 2016; von Hippel, 1994).

More recently, the role of Making in a crisis has emerged as a phenomenon of study and there is growing interest in how digital fabrication can help to address global challenges (Corsini and Moultrie, 2019). A review paper by Corsini et al. (2019) analysed how digital fabrication is used in the humanitarian and development sector, showing how 3D printing (and other digital tools) can offer design improvements, help to overcome supply chains challenges and contribute to local economic and social development. Furthermore, humanitarian makerspaces can support crisis-affected communities by empowering people to make solutions that the aid sector often overlooks (Corsini and Moultrie, 2020).

In the past, the Maker Movement has helped to tackle a number of pressing problems. For example, e-NABLE is a global community of digital volunteers who 3D print low cost upper arm prostheses (E-Nable, 2020); Makers in Gaza have been producing life-saving tourniquets since 2016 (Loubani, 2018); and the Forum for Digital Manufacturers in Nepal has been producing items to support post-earthquake recovery (Britton, 2018). However, these initiatives have been relatively small-scale and isolated from mainstream production activity.

2.4 Makers' responses to the COVID-19 crisis

The activities of the Maker community in response to COVID-19 have demonstrated the potential of this movement to solve pressing issues on an unprecedented scale. Since the very beginning of the pandemic and the subsequent lockdown of countries, Makers have autonomously stepped in to generate a variety of solutions useful to fight the sudden healthcare crisis, by coordinating local and regional networks to provide solutions for the health sector and civil society. These responses varied in complexity - from DIY face masks to emergency ventilators.

This study is an initial attempt to map and summarise this response and understand the challenges faced by Makers during this journey. By interrogating both qualitative and quantitative data on the Maker response to COVID-19, we aim to provide an initial understanding of the impact that these autonomous and distributed networks could have in our modern innovation systems.

3. Methods

In order to gain a complete understanding of the phenomenon, the study was divided in two parts: a macro-level data collection focused on identifying the characteristics of the global Maker response to the COVID-19 and a micro-level qualitative dive into the innovation process enabled by these informal networks aimed at capturing the challenges perceived by various making actors in the UK.

3.1 Global Maker response to COVID-19 (a macro-level perspective)

Between March and June 2020, the authors mapped the emergence of design/fabrication projects that were not being developed by large-scale incumbent manufacturers, but were being manufactured on a small, local scale by distributed actors as part of the maker ecosystem (i.e. peer to peer hobbyists, digital fabrication manufacturers and service companies, non-governmental organisations, research institutions, fabrication spaces) in response to the COVID-19 crisis. This mapping was done by monitoring and scraping social media posts, to stay close to the data as it emerged over time.

Projects were found by monitoring Twitter (using key hashtags), Makers websites (e.g. Wikifactory, JOGL), relevant Facebook groups (primarily: 'Open Source COVID19 Medical Supplies') and existing databases. The full source list is documented in Appendix Table 1. Multiple searches were done between 28th March and 1st June 2020. Initially, searches were run on a daily basis, however from 20th April as lockdown restrictions started to lift in different countries, searches were run on a weekly basis as it was observed that hashtags and posts were updated and used less frequently.

After a project was found, it was searched for on Google to find more detail to compile a database. This sometimes also brought up related projects. Projects were scanned for the following information: (1) project type (e.g. face mask, respirator, hand sanitiser etc.); (2) region (i.e. country, continent); (3) manufacturing technology (e.g. 3D printing, sewing machine); (4) type of actor (e.g. hobbyist, research institution); and, (5) project start date.
Several efforts were made to accurately identify the project start date. If there was a social media account associated with the project, the first post on social media was used. If there was an associated Google Doc for the project, the date the document was created was used. When a date was stated on a website as an approximate date, e.g. 'mid-March 2020' corresponded to the month of March and the week starting 16/03/20. Any projects where the start date could not be identified initially were searched for again using the Internet Archive's Wayback Machine (using the first date the website was found ensuring reference was made to covid-19), or the HTTP Header Checker.

Despite our efforts to systematically analyse as many projects as possible, we recognise that there are some limitations to our methods. First, any project without a digital footprint will not have been recorded. Second, the authors only searched for projects in English. Third, data was scraped data using personal social media accounts that may have led to geographic bias towards projects based in the Global North. Any interpretation of our findings should be made with these limitations in mind.

3.2 Maker response to COVID-19 in the UK (a deep dive)

Within the emerging database of global Maker responses to COVID-19 it was found that several initiatives originated from the UK. This provided an excellent opportunity to integrate and investigate more closely the perspective of Makers in the study, given the researchers' existing network with the Maker community in the UK.

The authors adopted a digital ethnographic approach[1] in order to analyse the content of a seminar (Postill and Pink, 2012) organised and hosted together with Dale Dougherty of Make:[2]. For the webinar[3], the authors invited four panellists representing seminal members of the UK maker response to COVID-19 that had received significant media attention. The speakers included:

- Ward Hills, one of the directors of Makespace Cambridge – the community's inventing shed in Cambridge which has been actively involved in producing PPE for the local NHS centre;
- Adam Clarke, Marketing Director of 3Dcrowd UK – a coordinating platform for the production and distribution of PPE/Face shields to NHS workers;
- Mike McEwan, board member of Shield Collaborative – a cooperative of thirteen initiatives for the production and distribution of PPE for health workers; &
- Kate Hammer, founder of CareSleeves, a project seeded within Shield Collaborative.

During the panel talk and discussion, several cross-cutting themes emerged from the case studies. We summarise the main discussion points from the webinar, and reflect on them more broadly to pose recommendations for how the Maker community can more effectively support crisis response in the future.

4. Results

This section will first highlight some of the key patterns found in the database of global Maker responses to COVID-19, before identifying key findings from our analysis of the UK Maker community.

4.1 Global Maker response

The full database of Maker responses can be accessed via Google Sheets using this link.

[1] Digital ethnography is an emerging set of methods, which describes the way in which researchers engage with online content and participate in digital platforms to archive and retrieve data.

[2] Make: is a US organisation that was founded in 2005 by Dale Dougherty with the vision of connecting an international network of makers. The webinar was part of a wider series organised by MAKE: magazine where makers' organisations involved in the crisis in various countries (in the US and Europe) were interviewed on their perceived challenges and achievements.

[3] https://youtu.be/Aq0mWoPlgqU

4.1.1 Project Type

Face shields and face masks represent more than half of the sample, while almost a quarter is represented by ventilators (See Figure 1). Face shields and face masks are essential PPEs that help protect from respiratory droplets from coughing and sneezing. Hence, a shortage of these items was perceived as a huge risk for both frontline workers and the general public at the start of the pandemic (WHO, 2020c), heightening the risk of COVID-19 infection.

Governments' response was slow, as scaling up production for such items required time and a great deal of investment in repurposing entire supply chains across the globe. Instead, the flexibility of the design and production process of the Maker movement enabled skilled individuals to immediately start tackling this problem. This resulted in a great number of projects that were rapidly replicated thanks to the sharing of blueprints online in March.

The majority of responses in all four cases were recorded in March and then started to drop steadily. Only face shields significantly peaked in April, in a contrasting trend. The authors speculate that an initial increase in the production of face shields followed the early success of these projects. As opposed to other products such as face masks and ventilators, face shields were largely exempt from being classified as medical devices which meant that Makers were able to distribute and implement these products more easily.

These four main categories of projects reflect how Makers' responses had to fill in institutional voids in current supply chains and hence had to operate under a "done is better than perfect" ethos, which called for a rapid prototyping and agile manufacturing approach.

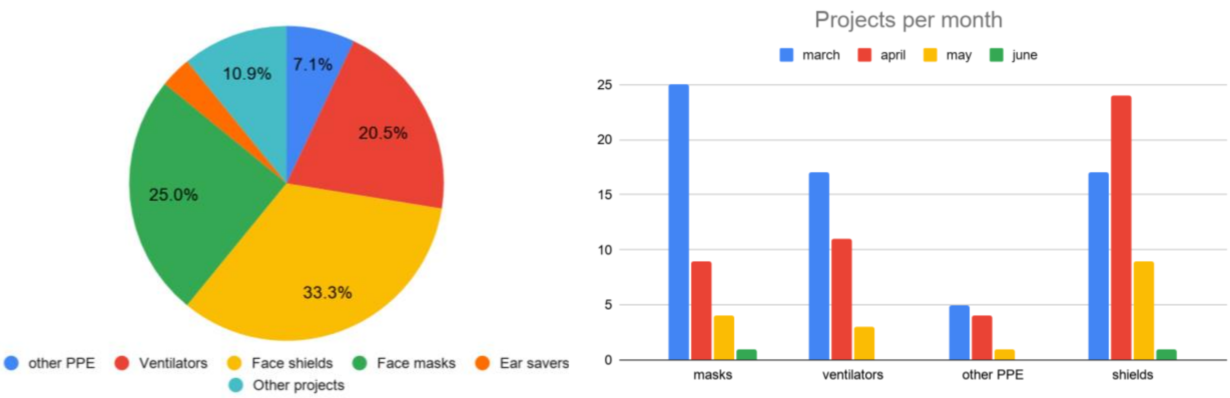

Figure 1. Overview of project types (top) and types of project started each month (bottom)

*Notes: *The "Other projects" category captures the range of more novel maker responses including door openers, testing kit components and sterilisation equipment; **The "Other PPE" category includes other protective equipment like garments or ear savers, and any type of PPE that is not face shields and face masks.*

4.1.2 Region

Figure 2 shows that the majority of responses arose from the US and Europe (particularly the UK). However we see an upsurge of responses from the Global South as well, predominantly in South and South East Asia. Broadly speaking, it can also be said that the geographic distribution of responses seems to corroborate with early geographic spread of cases. The first cases of coronavirus were reported in the US and in Europe on 21st and 24th January 2020 respectively however they were not reported in Africa and Latin America until after mid-February (ECDC, 2020).

It is perhaps not surprising that the majority of Maker projects seem to be reported in the North, where the Maker movement has largely dominated to date. The dispersion of digital fabrication tools and Maker communities has had a head start in higher income regions, which have relatively greater access to digital infrastructure and technologies. However, the authors are also mindful that their own networks (predominantly rooted in the Global North) may have limited the search and documentation of projects from other regions

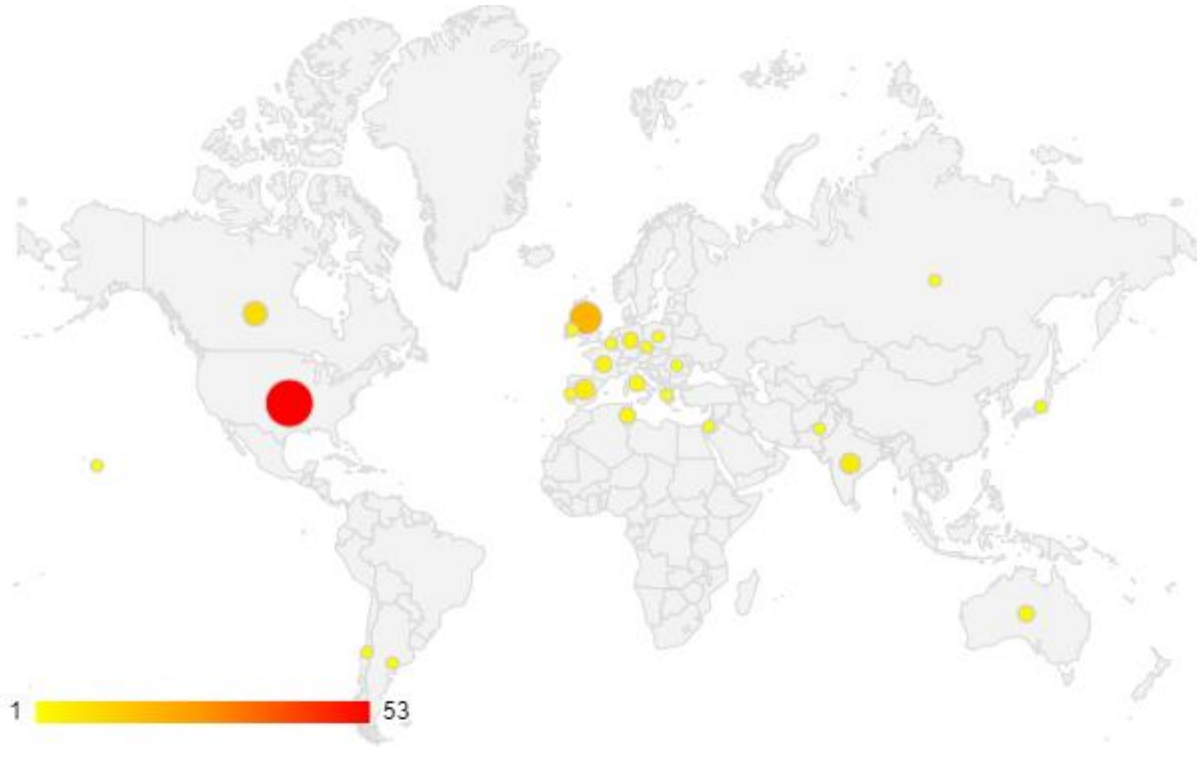

Figure 2. Geographic distribution of Maker projects

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4.1.3 Manufacturing Technology

The majority of projects (71) focused on 3D printing, with the next largest category reported as Home DIY (e.g. sewing, cutting and sticking). While laser cutting, injection moulding or other workshop technologies (e.g. lathe, bandsaw) usually require affiliation with an institution (i.e. a fabrication space) due to their high cost, 3D printing is an extremely versatile technology which has become increasingly easy to access and low cost. Nowadays, it is not that uncommon for private individuals to own a personal desktop 3D printer (Ryan et al., 2017). It follows that Makers, both affiliated and not affiliated to an institution, were able to more easily tap into this technology to quickly prototype initial design solutions when shortages in PPEs threatened national health systems. This finding further reinforces the widespread idea of how 3D printing technology is radically challenging the large and centralised nature of our current manufacturing system and shifting the lens towards a more distributed alternative (Corsini et al., 2020; Petrick and Simpson, 2013).

The case of Isinnova (Sher, 2020) the Italian rapid prototyping start-up that 3D printed life-saving valves for ventilators at the very start of the pandemic in Italy, clearly demonstrates this potential. The pressing situation that COVID-19 imposed on the local hospital of Brescia meant that respirator valves had to be quickly replaced at a faster rate than what the manufacturer's large-scale production paradigm was able to do. Instead, the team at Isinnova was able to produce a total of 100 life-saving valves in under 24 hours using their local network of 3D printers and hence provide a quick solution to an urgent and vital problem.

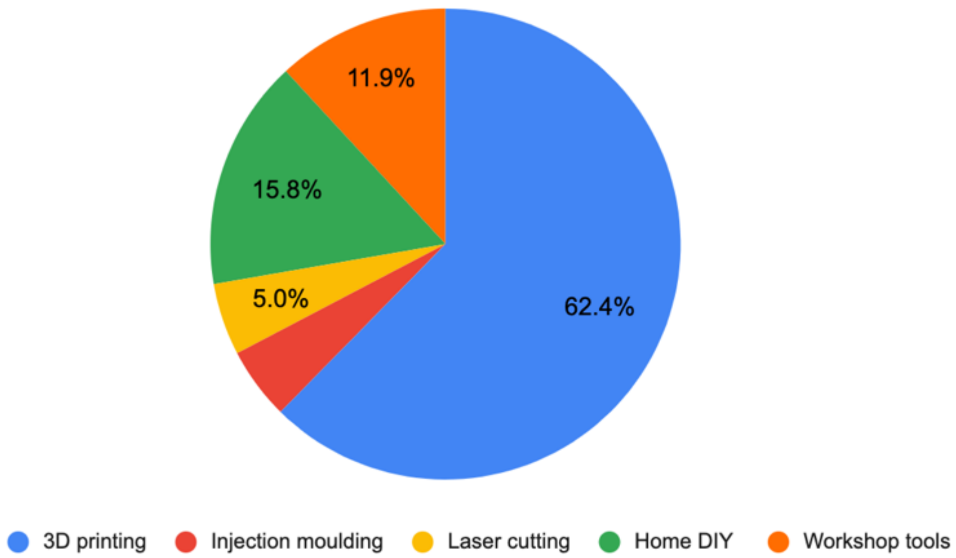

Figure 3. Overview of Maker projects by manufacturing technology

4.1.4 Type of Actor

Exactly who is a Maker (and who is not) has been the subject of much debate in the Maker movement (Hepp, 2018). Anderson (2012) defines Makers with respects to three key characteristics: 1. the use of digital technologies to create designs; 2. an ethos of collaborative design and peer production; 3. the use of digital fabrication tools and spaces. Elsewhere, the term 'Maker' is used as an umbrella term to refer to non-professionals who collaborate to develop Open Hardware (Menichinelli et al., 2020). Other researchers have pointed out that the identities of Makers are ambiguous but that they are related to a subculture which is antagonistic to mainstream production actors (Whelan, 2018). Kostakis et al. (2015) explain that the hacker ethic centres on "autonomy as well as of free access and circulation of information; distrust of authority, that is, opposing the traditional, industrial top-down style of organization".

Given the lack of consensus about who is a Maker, it was decided to focus our mapping on all open source projects developed in response to COVID-19, rather than on those developed exclusively by fabrication spaces' members. This allowed us to gain a broader view about who was involved in such "Maker projects" i.e. design/fabrication projects that were not being developed by large-scale incumbent manufacturers, but were being manufactured on a small, local scale by distributed actors. It was found the majority of projects were indeed initiated by unaffiliated hobbyists (i.e. private individuals), revealing a highly informal Maker network which extends beyond memberships in fabrication spaces. The highly informal nature of this network represents a significant challenge for the management and coordination of future innovation responses (which we discuss in the next section). Of note, just over a quarter of projects are by digital fabrication manufacturers or service providers. This signals the potential influence of these relatively well-established actors in contributing to the wider Maker community

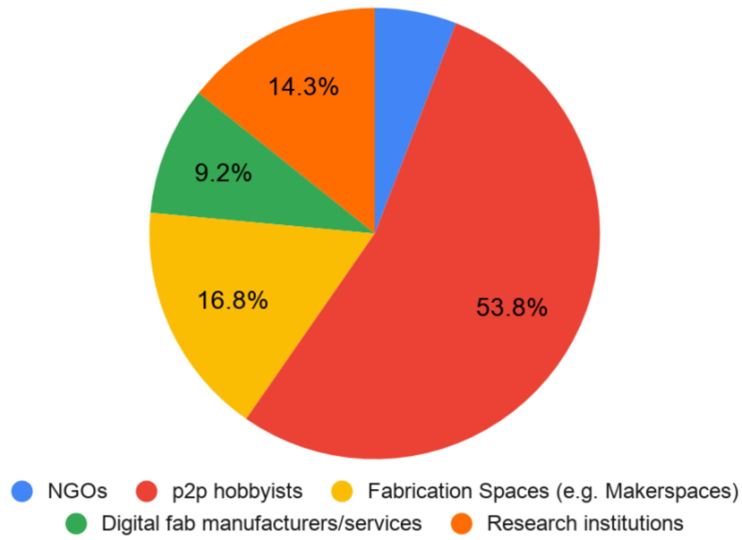

Figure 4. Overview of type of actor initiating project

4.2 Maker response to COVID-19 in the UK

Among the 157 projects that were documented, 19 projects were initiated in the UK. This section aims to discuss the perspectives of the UK Maker community. It specifically draws on key insights for the "Make Plan C: Maker Response to COVID-19 in the UK" seminar hosted by the authors.

4.2.1 Lack of a formalised national network

First the webinar brought to light that unlike other countries (including France, Germany, Spain, the US, the Philippines and Bhutan), there is no national network of Makers in the UK. In 2015, Nesta published an open database of makerspaces in the UK in a ground-breaking project to map the makerspace ecosystem (Nesta, 2015). Since, then there has been little work at a strategic level to coordinate activities between these makerspaces. For the most part, fabrication spaces and more broadly the Maker community operate as locally-driven and independent initiatives. To this extent, the panellists in the webinar referred to the importance of leveraging their own personal networks to establish effective collaborations. In these cases, their own social capital made it possible to access the resources they needed, however this led the authors to question what happens when personal networks are not enough? And how might makerspaces talk to one another in a more effective way? Perhaps one answer might be the creation of a national network for makers.

4.2.2. Lack of clear communication on the demand side

Second, a major challenge for the Maker community responding to COVID-19 was a lack of understanding about existing demand for critical items. Early on in the pandemic, poor linkages between healthcare practitioners and Makers was identified as a barrier for the effort of the Maker community (Corsini, 2020). It was also noted by the panel that in some instances healthcare practitioners struggled to precisely define their own needs, as the crisis situation was escalating so rapidly. Some organisations were set up to specifically tackle this issue. For example, 3D Crowd UK established itself as a coordinating body that could help to match demand for face shields between front-line workers and volunteer Makers. Despite other attempts to track demand for PPE across the UK (e.g. PPE model supplies), these efforts fell short of offering a centralised database that could effectively track and match demand and supply in real-time. It is clear that going forward, there needs to be a centralised and coordinated platform for recording and sharing information on local demand and supply for critical items in a crisis. Such a platform should consider 'supply' from actors beyond just the Maker community. For example, the UK Department of Business, Energy and Industrial Strategy posted online forms requesting information of possible manufacturing 'supply' as part of their Ventilator Challenge (GOV.UK, 2020). Any database should consider Makers as part of an integrated manufacturing network of supply.

4.2.3 Distributed quality control

Third, the webinar led to some interesting discussion about the inherent tensions between the possibility for Maker culture to support local adaption, and at the same time the need for the standardisation of production. Maker culture is inherently linked with 'tinkering', an activity that is made possible through the availability of open source hardware which enables people to locally adapt and replicate designs (Dougherty, 2012). This approach has clear advantages in that it allows for Makers to adapt their designs to local needs, as well as local resource constraints. For example, the dimensions of a face shield design can be adjusted according to changing availability of materials. Whilst this solves the problem in hand it introduces new challenges for the standardisation of production, which is fundamental for ensuring the production of professional quality items. Initial work has looked at crisis-critical intellectual property (Tietze et al., 2020) and it is vital that this research is further developed to address the concerns of the Maker community. It is also important to remember that the Maker Movement reflects a community that has organically developed and that has been primarily concerned with design and prototyping. The reconfiguration of fabrication spaces into manufacturing spaces therefore demands an expanded set of skills, as well as a shift in cultural mindset.

4.2.4 Volunteerism and innovation

Finally, the conversations drew attention to the latent innovation potential of the general public in the UK. It was unanimously agreed that the Maker community across the UK had significantly contributed to the response phase of the COVID-19 pandemic through the production of hundreds of thousands of face masks, face shields and other critical items. For many people this was their first touch-point with the Maker Movement. Whilst the discussion suggested a potential activation of community networks that could help to transform society (for example, 3D Crowd UK is being repurposed into a 3D printing organisation for social impact), it also highlighted concerns about the sustainability of volunteer-driven activities. Many Maker activities have been largely dependent on donations of money, time and resources. We simply ask: will people be willing to do this another time? Will there be the same level of enthusiasm or outpouring of donations? Without idle capacity, how could this response be possible?

5. Conclusions

In this working paper we have offered two different perspectives on Maker responses to COVID-19. To begin with, we analysed the characteristics of global Maker initiatives responding to COVID-19. These findings have helped to evidence the impact of the Maker community by highlighting the types of projects, production technologies, actors and geographical dispersion of Maker initiatives. In the second part of our study, we looked at the impact of the Maker movement during COVID-19 by documenting the experiences of the Maker community in the UK. Adopting a digital ethnographic approach, we analysed a panel talk co-hosted by the authors with four Maker initiatives in the UK. Analysis of this discussion provided rich insights into the drivers and barriers to community-based Maker responses to crisis, specifically focused on the UK Maker ecosystem. This analysis has led to development of several key recommendations, as well as questioning the sustainability of the Maker response. Now that most countries are easing lockdown measures and passing peaks, what will be left of these makers projects? Can Makers' prototypes be turned into more than proof of concept?

Looking to the future, the authors of this paper call for the development of a national network of Makers in the UK that is recognised and supported at a policy-level. In addition, the authors strongly recommend the development of a centralised platform for coordinating local demand and supply for critical items. Such a platform could be quickly mobilised in a crisis to help join up demand. Finally, there is a clear need for further research to address the pressing challenge of distributed quality control. Overall, the authors hope that this work provides a foundational knowledge for understanding the potential and challenges of Maker responses to crisis. Having highlighted some key concerns, we call for cross-sector collaboration to ensure that the lessons learned from this pandemic can help to shape more effective responses to future crises.

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7. Appendix

Table 1. Data sources used to document COVID-19 Maker projects

Facebook https://www.facebook.com/groups/opensourcecovid19medicalsupplies/
Twitter #makersagainstcovid #covid #covid19 #opensource #BuildforCOVID19 (this tag is now being used for hackathons) #OpenCovid19 #maker #covid19 #3dprint #covid19
Databases https://airtable.com/shrPm5L5I76Djdu9B/tbljebukv5EXbCqST/viwVGvMNqbUIoFiyn?blocks=bipjdZOhKwkQnH1tV https://docs.google.com/spreadsheets/d/1inYw5H4RiL0AC_J9vPWzJxXCdlkMLPBRdPgEVKF8DZw/edit#gid=0
Websites https://makersagainstcorona.org/ https://www.thingiverse.com/groups/HackThePandemic/members https://wikifactory.com/+wikifactory/stories/coming-together-as-an-open-community-for-viral-response?utm_source=instagram&utm_medium=banner&utm_campaign=viralresponse1 https://makezine.com/2020/03/22/whats-plan-c-for-covid-19/ https://app.jogl.io/project/121#about https://preciousplastic.com/covid-19 https://app.jogl.io/program/opencovid19 https://jogl.io/ https://makezine.com/2020/04/13/ranking-open-source-ventilators/ https://enoll.org/wp-content/uploads/2020/04/maker-community-report-final-.pdf https://www.makery.info/en/ https://covid-initiatives.org/ https://app.jogl.io/program/opencovid19 https://www.projectopenair.org/en/ https://tomglobal.org/community?id=5e73198894711e10b13ebe3b https://helpwithcovid.com/projects/13 https://www.coventchallenge.com/ https://web.makespace.org/Covid-19/ https://www.stuck.sg/covid-19/ https://makerfaire.com/virtually-maker-faire-2020/schedule/ https://www.makervsvirus.org/ https://www.makery.info/en/2020/05/20/reponse-de-crise-au-royaume-uni-les-makers-en-ordre-serre/