Plan C – "makers' response" to Covid-19

Introduction

The declaration of a Covid-19 pandemic on 11 March 2020 lead to a number of reactions and effects, such as local and national lockdown measures, increased hospitalisation of patients, and a related surge in demand for different medical and non-medical items which causes interruptions in the globalized supply-chains.

Just two days after the declaration of the pandemic, on Friday, 13 March, in a hospital in Brescia, Italy, one particular part of a breathing apparatus (a valve that changes speed and pressure in the airflow, called the "venturi") broke down and there were no replacement parts available. Through personal connections, the doctors managed to find an engineer at a company specialised in 3D-printed prototypes who was able to reproduce the part within 24 hours. The contact was allegedly brokered by the founder of a fablab and tech journalist, Massimo Temporelli (Sher, 2020a). This story made the headlines in the European and global press, early into the declared pandemic, and the fablabs and 3D printing were inextricably linked to fixing supply chain tribulations for healthcare.

The people in Brescia extended their work by proposing to use a Decathlon snorkelling mask as an improvised breathing aid at a time when these machines were believed to become the bottleneck in treating CoVid-19 patients (Sher, 2020b). Makers all across Europe and world-wide started to replicate the piece that would attach Decathlon masks to hospital breathing equipment. That's how the virus first infected the "maker movement". Although Decathlon shortly after stopped selling the masks and hooking-up the scuba masks to medical devices proved more difficult than expected, makers globally continued to develop these devices that presumably were short in supply.

The idea that self-organizing groups of makers defeated global supply chains by producing locally supplies – particularly personal protective equipment – for the medical professions, meeting the ongoing needs of healthcare organizations, quickly became part of the narrative of the self-assumed "maker movement", presented as a seminal example how distributed manufacturing could effectively and efficiently rise above the deficiencies of globalized supply-chains and centralized manufacturing and hence contribute to a transition to peer-production of physical goods. Particularly vocal in this endeavour was the programme "Plan C Live", initiated by Dale Dougherty of former Maker Media and driving force behind "Make Community", the successor of Maker Media.[1]

[1] Similarly, the annual fablab gathering, in 2020 online as fabxlive, promoted the "global response to CoVid-19" in its opening session.

Background

Making as peer-production

In the early 2000s, several prominent figures proposed that a "maker movement" would bring about a tangential development in technology design and production. Neil Gershenfeld (2005) called it personal fabrication, the "coming revolution on your desktop". The same year, Mark Frauenfelder and Dale Dougherty launched *Make: magazine,* Massimo Banzi and David Cuartielles presented their first Arduino boards that made microcontrollers easily accessible to artists and tinkerers, and Eric Wilhelm launched the online platform *Instructables* where people could share instructions on how to make things from as tree houses to 3D printed bionic hands. We called this the "year zero of making" (Boeva & Troxler, 2021, p. 226; Troxler, 2015, p. 61).

This journal has, on various occasions, investigated making as peer-production. We found that shared machine shops were not new, sharing was not happening, or hackerspaces were not open (Troxler & Maxigas, 2014). We studied feminism, making, and hacking (Bardzell et al., 2016) and the institutionalization of shared machines shops within universities and corporations and found that they redefined making's origins and prospects (Braybrooke & Smith, 2018).

In my own research on making as peer production I have decidedly remained ambivalent. I have been sympathetic to the narrative of making being a form of peer production (Troxler, 2010, 2011). I have acknowledged what fab labs and similar spaces have achieved (e.g. Troxler, 2018). I have highlighted the struggle for polycentric structures and a new peer-production commons in the fab lab community (Troxler, 2013). I have pointed out that there was more needed than the core making technologies, 3D-printing and laser cutting – like becoming sustainable, developing the network, embracing a lateral paradigm (Troxler, 2015), eschewing technocracy (Troxler, 2016b), and building a commons (Troxler, 2017, 2019). And I have asked myself what in making as peer-production (of open hardware) could become an equivalent to infrastructure projects in open source software such as the Apache web server (Troxler, 2016a).

So, was producing personal protective equipment for healthcare and related sectors such an infrastructure project?

Framing the "makers' response" as a paradigm change with transition theory

Book titles that invoke a "next revolution" (e.g. Anderson, 2012; Gershenfeld, 2005) allude to something radical happening in their subject area – in this case the production of things. In science, such revolutions have attracted the interests of philosophers such as Kant and, more recently, Kuhn. In his treatise of "the structure of scientific revolutions", Kuhn (1962) describes this structure as consisting of four steps – first, the dominant paradigm active in normal science, second, anomalies in normal science leading to extrapolatory activity or "extraordinary research", third, the adoption of a new paradigm that gradually replaces the

old one (as its incumbent adepts eventually die), and fourth, in the aftermath of the scientific revolution the new paradigm becoming the new normal.[2]

Based on the works of Kemp (Kemp 1994; Rip & Kemp, 1989; Kemp et al., 2001), Geels discusses technological transitions as evolutionary reconfiguration processes (Geels, 2002; Geels & Schot, 2007). A central concept in Geels' model is the sociotechnical regime (p. 1260), as "technological regime" defined by Rip and Kemp (1998):

> "A technological regime is the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems; all of them embedded in institutions and infrastructures" (p. 340).

Sociotechnical regimes are at the centre of a multi-level perspective on technological transitions. At the meso-level they form a relatively stable patchwork that is embedded in a landscape of slow changing external factors at the macro-level. At the micro-level, novel configurations appear as potentially radical innovation in technological niches. If conditions are right, these innovations have the potential to change or replace dominant sociotechnical regimes. Such conditions, according to Geels (2002), are:

- A window of opportunity at the regime (meso) or landscape (makro) level – tensions in the sociotechnical regime, shifts in the landscape
- Innovations gradually stabilising into a dominant design
- Technological "add-ons", i.e. new technologies used alongside old ones to overcome some of their particular deficiencies or bottlenecks
- Growth in particular (niche) markets where new technologies are preferred over old ones

Transitions come about when the dominant structures in society (regimes) are put under pressure by external changes in society (landscape) as well as endogenous innovation (niche). Under certain conditions, seemingly stable societal configurations can transform relatively quickly – i.e. much faster than the 40-60 years in the example of the replacement of sailing by steamships in the second half of the 19th century (Geels, 2002, pp. 1263-1270). Loorbach (2007) for instance gives 15+ years for long-term systemic and cultural change on the macro level, 5-15 years for structural, institutional and regime change at the meso level, and up to 5 years for micro level innovations, e.g. in terms of change of certain practices.

The central assumption is that societal systems go through long periods of relative stability and optimisation that are followed by relatively short periods of radical change. Transitions as processes of 'degradation' and 'breakdown' versus processes of 'build up' and 'innovation' (Gunderson and Holling, 2002) have been witnessed in history, e.g., the transition in the mobility system from the horse-carriage to the automobile (Geels, 2004).

From an initial analysis, the situation of the Covid-19 pandemic appears to fulfil a number of Geels' conditions:

[2] It seems no coincidence that in the context of the pandemic politicians talk about a "new normal" that would replace how people used to live with their state-controlled, virus-compatible version.

— The pandemic created a *window of opportunity,* with the pandemic as a shift in the landscape and supply shortages as a tension in the sociotechnical regime of healthcare.
— The technical innovation of 3D printing, one core technology of making as peer-production, had stabilised into a *dominant design* (Deloitte 2019), available on many levels from amateurs reproducing science fiction figurines to commercial manufacturing.
— The technology has become an *add-on*, ranging from prototyping products for later mass production with other manufacturing technologies to replacing conventional manufacturing for various applications.
— The *(niche) market* of making as peer-production has often been preferring 3D printing and laser cutting technologies are over the old ones of manufacturing or the crafts.

So, from a transition perspective, was producing personal protective equipment for healthcare and related sectors that novel configuration that could spur radical innovation from its niche into the wider sociotechnical regime?

Method

To chart the flurry of "makers' responses" world-wide appeared a bootless task – despite being aware of many initiatives to collect and connect local initiatives on various social media platforms. For instance, a design focused collection of "everything" Covid-19 related that appeared in design blogs and specialist websites assembled and categorized over 500 designs – maps, charts, visualizations, products, networks, etc. – over the period of the first five months of 2020 (Galdon et al., 2020) and analysed their temporal and geographical distribution. And while this collection used the keyword "makers", it is far broader than what the "makers' response" entailed, and their analysis of the contribution of "makers" remains superficial. Other organisations who were supposedly better positioned to keep track of activities struggled to produce meaningful results; the Fab Foundation, for instance, representing some 1750+ labs world-wide only included 65 labs in their survey, of which 41 responded (Fab Foundation, 2020).

Therefore I reverted to the organization at the heart of the mediatization of the "pioneer community" of makers (Hepp, 2016) – Dale Dougherty's *Make: Community* and their online show "Plan C Live" that covered "makers' response to Covid-19". These shows were held on Zoom, streamed on facebook, and subsequently published to YouTube. Between April and November 2020, Dale – together with colleagues Mike Sense, editor at *Make:,* and Dorothy Jones-Davis, executive director of Nation of Makers – held 23 panels on the "civic response" to Covid-19 (see Table 1).

The shows covered a variety of topics, about half of them (11) addressing the local response in particular cities, by specific organisations, and in selected European countries. Others were discussing specific projects like ventilators, masks, or even a vaccine (3). Several shows discussed issues specific to maker spaces (4), maker education (3), and community matters (2).

From the 23 shows, I selected the 5 shows that addressed the "makers' response" in European countries, marked bold in Table 1 – the other shows were US-centric. I had several reasons to support this choice. First, the response to the pandemic in the United States

appeared to be quite different to the response in many European countries. Second, differences in the healthcare system between the US and Europe might have led to inverse stereotypical misinterpretations we tend to attribute to US-centric analyses of Europe. Third, my personal knowledge of the situation of makers in Europe is much more involved than that's the case for the US. The 5 Europe-centric shows amounted to about six hours of video material.

*Table 1. "Plan C Live" panels. The shows marked with * were hosted by Mike Sense, those marked with ** were hosted by Dorothy Jones-Davis. The EU-centric shows, marked in bold, were co-hosted by one (in the case of the UK: two) local co-host(s). The topic codes are C for community matters, E for maker education, L for local response, M for maker spaces, and P for specific projects.*

Date	**Title** [between brackets the duration of the recording in hours, minutes and seconds]	**Topic**	**Number of panellists**
14 April 2020	Tracking and Ranking Open Source Ventilator Projects [30:36]	P	5
16 April 2020	The Maker Response to a Global Pandemic [59:00]	L	5
24 April 2020	Citizen Response (Chicago) [1:10:15]	L	9
29 April 2020	with Dr. Neil Gershenfeld and Sherry Lassiter [1:03:42]	L	5
29 April 2020	**The Civic Response in** Spain [1:26:00]	**L**	**8**
6 May 2020	Maker Activation in Atlanta [57:31]	L	8
8 May 2020	Montana Mask [55:25]	P	8
15 May 2020	**Maker Response to Covid-19 in Germany** [1:10:33]	**L**	**6**
19 May 2020	The Asylum Saves Us [38:14]	L	3
11 June 2020	**Maker Response to Covid-19 in France *** [1:21:08]	**L**	**7**
12 June 2020	Fix it Yourself – Repair in a Pandemic [57:54]	C	4
17 June 2020	The Keys to Re-Opening Makerspaces [1:07:08]	M	9
19 June 2020	The Keys to Re-Opening Makerspaces * [1:03:05]	M	8
24 June 2020	Re-Opening Makerspaces in Libraries [1:03:12]	M	9
8 July 2020	**Maker Response to Covid-19 in the UK** [1:08:36]	**L**	**4**
10 July 2020	Re-Opening University Makerspaces [1:01:35]	M	5
17 July 2020	Informal Learning [1:12:36]	E	3
31 July 2020	K-12 Maker Educators [1:06:30]	E	7
7 August 2020	Educational Kits [1:10:36]	E	9
14 August 2020	Rapid Development Vaccine Collaborative (RadVac) [1:01:46]	P	9
21 August 2020	Impacts of Covid-19 in Northwest Louisiana ** [1:18:09]	L	4
4 September 2020	Building Resilient Communities [1:05:14]	C	6
30 November 2020	**Maker Response to Covid-19 in the UK** [approx. 1:10:00][3]	**L**	**4**

The Europe-centric shows followed a common pattern. After the opening by the host, the local co-host would give an overview of the developments in the country. Thereafter, the individual panellists would have approximately ten minutes to present their own activities. Then, a discussion of the developments in the respective country followed. The show would conclude with questions and answers from the host and from supposed outside participants.

[3] No recording available as of 15 December 2020.

For this paper I created an extended description of each show based on an individual close viewing of the recording and the related auto-generated closed captions file provided by YouTube and downloaded via the downsubs.com service. An exception is the 30 November UK show that reviews the development since the first UK show in July. Since no recording of that show has been posted to YouTube at the time of writing, close viewing and closed captions were not available for this show. The following section summarizes those extended descriptions per show.

Data

Spain, 29 April 2020

The panel was held on 29 April 2020 (Make:, 2020a) – that was seven weeks into the pandemic, Spain had been in lockdown for a month, all non-essential activities halted, including construction and industry until 13 April; the Spanish government had just announced a plan for easing down restrictions.

The local "Plan C Live" session co-host was Karim Asry, co-producer of Maker Faire Bilbao. He sketched the situation in Spain as "the hardest hit of all countries". Against that backdrop, the makers' response resulted in what he called "the largest manufacturer of PPE in the time when it was most needed".

The panel included (in sequence of appearance)

- David Cuartielles Ruiz, co-founder of Arduino and professor of interactive technologies at Malmo University, who talked about the website and forum infrastructure set up in Spain as well as of the need to connect the digital, the physical and the economic sphere.
- Rosa Nieves León Pérez, national coordinator of coronavirusmakers.org, who described how organizing the makers' response regionally in the 17 administrative regions was instrumental to make a meaningful contribution.
- César García Sáez, co-founder of makerspace Madrid, who talked about the social media platforms and the symbolic relevance of face shields as "minimal viable help"
- Miguel Ángel Fernándes Rodrigues, physicist in colloids and interfaces at the Unviersity of Barcelona, who talked about medical standards and the importance of sharing of prototypes with the medical profession, even if they are not supposed to be put to clinical use.
- Mary Almazán, fashion and sustainability engineer, who talked about connecting local manufacturer of (protective) garments and developing a "democratic" face mask that people could easily produce themselves.
- Delia Millán and Mickael Pitaressi, of fab lab Cuenca, who elaborated on the local collaboration and co-design activities between the maker space, the doctors from the local hospital, and local businesses.
- Javier Fernandez, a member of makerspace Madrid, reported on the activities of makerspace Madrid, producing face shields initially, but then getting involved in the

development of open source respiratory apparatus that they named the “Apollo ventilator”[4].

“Makers’ response” in Spain had started online on 14 March 2020, David recalled, when he, together with Cesar, was working on setting up a forum where people could exchange ideas and experiences about producing open source ventilators. The same day, Miguel Angel Casanova had registered the domain coronavirusmakers.org. The site and forum quickly became the place to go in the Spanish speaking community, and the forum registered over 200 GB traffic[5] in the first few days, much more than what David ever experienced when running the forums for Arduino.

Apart from the site and forum, an unspecified number of Telegram and WhatsApp groups were emerging, as Cesar recalled, although he supposed that not many doctors were using Telegram. Indeed, Delia and Mickael confirmed that they used an “app group” to connect makers and doctors. Making connections between makers and other actors was a recurring

A key ingredient in the “makers’ response” was collaboration in different areas. First and foremost, the cooperation with doctors and other healthcare professionals. Often, this cooperation was initiated by doctors themselves. Reportedly, co-designing was a novel experience for doctors, and they benefitted from improving utensils in several iterations. The other important area of collaboration was the supply chain, particularly in terms of logistics, the supply of materials and the scaling-up of manufacturing. For instance, David estimates that companies donated six or seven tons of filament for 3D printing of utensils. Miguel Angel reports the example of a respirator mouthpiece made from silicon which cannot be easily 3D printed. So, the samples had to be injection moulded. The company providing the samples had covered the costs of the mould of € 5.000, a sum that is out of reach of a regular maker or maker space.

A topic touched upon several times was regulations and standards, particularly in the medical sector. And while makers would be able to fast-track the development and production of utensils, the general tone in the panel was that makers should and would not want to compromise the health and safety of doctors, nurses, or patients with makeshift products. Bringing administrators and makers together was seen as a challenge, but it was suggested that universities could possibly play a mediating role.

Asked if makers now were accepted as “real R&D talent” the panel remained cautious, they felt it was too early to know, and some doubted the R&D capacity of makers. There was a flurry of news, however, that was more focused on 3D printing rather than the makers.

A final question touched on the financing of the “makers’ response”. A quick calculation by Rosa revealed that about € 100.000 worth of filament was spent on making utensils like face shields, door openers and ear savers alone – using up stock and material donations. There

[4] Apollo is a registered trademark for respiratory apparatus in the US and Japan, hold by Draeger; knowing makerspace Madrid the name choice is probably not coincidental (these are the footnotes that cost you an hour of your life …).

[5] As a comparison, the OECD reports that the average internet user downloaded each month 5.8 GB per subscription.

remained, however, doubts about the longer-term economic future of maker spaces that were heavily dependent on membership fees, and funding campaigns were ongoing.

Germany, 15 May 2020

The panel was held on 15 May 2020 (Make:, 2020b), two months into the pandemic. Germany's response to the pandemic differed to that in Spain as many measures, such as curfews and regulations concerning social distancing, mandatory facemasks, or closing schools, were state matters. Three states, Bavaria, Saarland, and Saxony went into lockdown in March. On 17 March non-essential shops and schools were closed, on 22 March, the government and the states agreed on limiting gatherings and closing restaurants and personal services. These restrictions were partly lifted – most shops could reopen as of 20 April. In early May, schools reopened but contact restrictions were left in place until June.

The local "Plan C Live" session co-host was Andreas Kopp, founder of fab lab Erfindergarten Munich, Bavaria. He sketched the situation in Germany as different to Spain – the main impression was that Germany had their supply of PPE under control, so makers in Germany could spend time strategizing and developing utensils.

The panel included (in sequence of appearance)

- Karsten Nebe, professor at Rhein-Waal University of Applied Sciences where he runs a fab lab. With the 3D printers from the lab relocated to students homes, they initially were producing the "Prusa shield" but then developed their own design of which they eventually produced one batch together with local companies and material supplied by the German Red Cross.
- Nils Hitze, co-founder of Maker Faire Munich, was instrumental in organizing and managing the community on the WirVsVirus Slack group which involved mediating discussions and the logistics for connecting people who were 3D printing with potential customers.
- Dominik Wilming, of the group Vechta gegen Corona (Vechta is a district in Lower Saxony) who got a local brought a network of local business together to produce the Prusa shields, including an injection moulding company.
- Peter Pröpper from maker space Bonn who was trying to keep their 3D printers free for prototyping and experiments and in the process of setting up a collaboration with Bosch.
- Anke Domscheit-Berg, a member of parliament, from Fürstenberg, Brandenburg, and involved in the local Verstehbahnhof maker space where they quickly moved from 3D printing to injection moulding of frames for shields which then were assembled in various local maker spaces, initially for local users. When local demand was met, they started to distribute internationally, for instance to a refugee camp in Syria, to the republic of Congo, and possibly to indigenous people in Amazonia.
- Tom Hansing, researcher at the foundation anstiftung and involved in the Verbund offener Werkstätten (a German association of maker spaces and similar shared machine shops).

Maker activity in Bavaria initially started with the lockdown and took initially place in the Facebook group OSMS (open-source medical supplies) – designing filters, respirators, etc. The German government organized a national hackathon on the weekend of 22 March called WirVSVirus – we against the virus (Bundesregierung, 2020) which became a pivotal moment for the "makers' response" in Germany. People moved from Facebook to the Slack

group of the hackathon were most national coordination and communication activities took place. Nils particularly highlighted discussions on price, on medical ethics, and advice from legal experts regarding for instance asserting effective protection.

The panel spent most of the time describing the local approaches to producing face shields, most of the panellist quickly involving local companies that could provide injection moulding to achieve relatively large production runs (several thousands). Partnering with local manufacturers was seen as beneficial, as 3D printing capacity could be used for fast iterations in the development and testing of parts. Also, local manufactures were able to supply materials that appeared to be sold out online.

The issue of certification is only referred to indirectly – as being possible, but time consuming and costly, as something customers did not ask for. Interestingly, many panellists decided to use the Prusa face shield – probably because Prusa is a trusted brand in open-source hardware. Yet the decision might also have been influenced by the CE certification of Prusa's own production process, their certification that the shield conforms to European PPE standards, and them mentionig "two verifications with the Czech Ministry of Health" on their website (Prusa Research, 2020).

With the presentation of Anke the discussion shifted also to the question of funding of the makers' response, particularly because Covid-19 related government emergency funding, available on national and state level, was not accessible for NPOs. The panel identified a reality gap – while the for-profit sector was incapable of reacting to the shortages but would receive government funding, the non-profit sector was delivering solutions but could not access financial support. A change in policy appeared much needed.

The panel concluded with an outlook to possible next steps, as the market for face shields was saturated. Two lines of action were sketched that both could fall under a minimal ethical framework of "we want to help people" (instead of making profits) – first, to maintain the network of local initiatives as "makers for sustainability" as it proved to be resilient in a period of chaos attributed to a break-down of the capitalist system, and second to expand on humanitarian help as "makers for humanity" which would need more international coordination.

The makers' response was a "new way of doing things" – an open production line, and an open R&D line – that could be relevant for a next wave of infections or any other crisis coming up. 10 years of open source and internet made the rapid response possible, the panel affirmed. The makers' response was on the right track to find stability in the non-market infrastructures for the public good, as Tom called it: "Being part of the big change we want to see."

France, 11 June 2020

The panel was held on 11 June 2020 (Make:, 2020c) – that was three months into the pandemic, France had been in lockdown for almost two months, between 17 March and 11 May – with cafés, bars, restaurants, schools closed and a travel ban internationally and outside a 100 km radius. On 2 June the travel ban was lifted, and cafés, bars, and restaurants were allowed to reopen, except for Paris that would follow on 14 June. Schools were still closed (until 22 June) and international travel was banned.

The local "Plan C Live" session co-host was Alex Rousselet, one of the initiators of the Vulca makers' mobility initiative and in charge of the external relations of the French fab lab

network. Before introducing the panel, he lists a few other actors who were part of the dynamics but could not attend the panel: Axelle, a Youtuber who made a video about how to make a face shield, Dimitry Ferriere, known as “Monsieur Bidouille” (Mr. Hack) created a forum, Anthony Seddiki created the project “Visière Solidaire” and Yann Marchall created the (French) facebook group “Makers contre le Covid”.

The panel included (in sequence of appearance)

- Constance Garnier who set up the multi-lingual (FR, EN, ES, IT) website covid-initiatives.org to make citizens’ initiatives and the actions of makers visible which was accompanied by a collection of personal stories of people becoming active in making in during Covid, from France and Spain (https://recits-solidaire.dodoc.fr). Constance was also forming a formal npo “solidaires pour faire”.
- Bertrand Baudry, curator of the Maker Faire France) replaced the Maker Faire France with a gallery of projects to inspire people at home and established the open badge “Covid busters” for makers.
- Matei Georghiu, scientific council coordinator of the French Fablab Network who as a sociologist was helping the main actors of the movement to understand where they were going and what they were doing.
- Matthieu Dupont de Dinechin, secretary of the French Fablab Network, which experienced the crisis as a “crash test” as the network at national level only worked for a part of the job, while other activities needed to be organized regionally – due to national travel restrictions – to be able to cooperate.
- Catherine Villeret who founded fabri Communs as a French platform to collect and connect the response of volunteers. The platform matched makers to demand on proximity (within the travel restriction limitationa), had the ability to track the manufacturing steps and facilitated collection and delivery via a volunteer transportation network.
- Thomas Landrain, founder and CEO Just One Giant Lab (JOGL), a platform that supported working together in open science projects, who set up a specialist Covid-19 section on that platform in five fields of activity – data analysis and simulation, validation of open source solutions, Covid-19 prevention, Covid-19 diagnostic and detection, and Covid-19 treatment – which as a collective endeavour realized same level of output as one would get from an academic laboratory.
- Roman Khonsari, pediatric surgeon at Necker hospital, Paris, who set up a 3D printing centre for the Paris trust of academic hospitals APHP as they were able to attract substantial funding from private sponsors.[6] The centre was successful in producing protective equipment for hospitals and schools; however, they were not able to produce medical devices despite various projects going on, which was due to regulatory demands that they could not meet. The centre was supposed to remain a development and production facility for the trust and a teaching centre for design and printing techniques with a particular focus on African countries.

The panel acknowledged that all of them – with the exception of Roman who was connected to the group via the JOGL project – knew each other from earlier occasions –

[6] A total amount of € 2.000.000 which allowed the centre to purchase 60 Stratasys FDM printers and raw material for 4 months and to employ 5 engineers for 4 months.

notably the Maker Faires in Lille and Paris, the Bidouille camp, the Fab Festival. They shared the urge to connect in times of crisis and to avoid doing double work, hence they started their platforms. What held them together was what Matei called the “maker spirit”, which is not geared towards making money but towards helping each other.

Given that there were economic actors like Amazon who profited from the crisis, while other sectors, such as tourism suffered, Matei expressed his astonishment that the makers’ initiatives did not financially exploit the market of PPE for making big profits when demand was high, and supply was scarce. Instead, everyone gave away PPE devices for free, “just for the glory”. He was asking if makers “as a timeless way of being but also as a brand new political, social and economic category” would interact with and modifie state, market, and society. While the classical business development model on the internet had become to distribute something for free and then to become the monopolist, makers did not want to become the monopolist. However, if they would continue distributing for free they would economically will kill themselves. So the challenge, according to Matei, was to build some economic model In which society could benefit from all the skills of the makers while still allowing them to make a living.

Regarding their interactions with institutions and policy makers, the panel painted a rather sombre image. The French department of health did not quite understand the request of the French Fablab Network to regulate for makers producing PPE. They had conversations with various regulatory agencies that lead nowhere. Roman confirmed this impression and relayed another experience of him talking to a specialist pharmacist in his trust. This specialist had the idea that 3D printing was mainly used to produce “gimmicks” so eventually their advice was to stop the activity of the 3D printing centre as it was probably illegal.

The last round in the panel addressed the question what the “maker movement” could learn from this experience in France. The panellists agreed that through working together on scale makers had made big steps and moved away from the image of “funny guys that make funny things for Maker Faires”. They had proven that they were developers and could act faster than companies and governments – or, as Constance put it, “the maker movement reached some kind of maturity: it’s time to get the licence to drive.” This drive, however, would also require a regulation system that was faster.

UK, 8 July 2020

The panel was held on 8 July 2020 (Make:, 2020d) – that was almost four months into the pandemic. The UK had been in lockdown since from 26 March until June – schools in England reopening on 1 June and shops on 15 June.

The local “Plan C Live” session co-hosts were Valeria Dammicco and Lucia Corsini, researchers at the Institute for Manufacturing ath Cambridge University.

The panel included (in sequence of appearance)

— Ward Hills, one of the six directors of Makespace Cambridge (he is one of the 6 directors) opens the panel. Two of its members were clinical engineers at Addenbrooke’s Hospital in Cambridge, and they were investigating if Makespace could deliver face shields. So, they set up and documented a manufacturing line and process to produce those shields and sourced material as a donation from a local business – a bakery that used the same type of clear plastic sheets.

— Adam Clarke, volunteer marketing director of 3D Crowd, a network of 3D printing enthusiasts, who described how they "built the decentralized Amazon of face shields in only four weeks", based on the Prusa shield design as it had already passed CE approval in Czechia. They were also trying to expand that into other areas: prosthetic limbs, home aids for the elderly and disabled, contributing to other Covid-19 related projects, and recycling 3D printing waste.
— Mike McEwan who as a medical devices consultant for start-ups got involved with a fundraising initiative called NHS hero support to procure PPE for the NHS frontline staff, and as a director with the SHIELD[7] collaborative that pursued a similar of providing PPE to frontline staff.
— Kate Hammer presentied the CareSleves initiative – supported by NHS hero support and SHIELD – that was aiming to provide sleeved garments to care workers (under UK PPE guidelines only certain clinicians are entitled to sleeved garments). The initiative brought together experts from a wide range of disciplines – sewing and engineers, a public health specialist with a background in anthropology and infectious disease control, a 3D & service designer, a materials engineer, a costume supervisor, to name a few, all working on 100% voluntary basis.

The panel agreed that there were a couple of challenges that their initiatives encountered, both had to do with the regulatory environment. First, it was impossible for unincorporated initiatives to open a bank account in the UK, so they needed to use pre-existing banking facilities of institutional partners. Second, the regulatory framework for PPE hat little room for "emergency creativity".

While some of the panellists had informal contact with regulatory bodies, those could not be communicated in the open. So, if they were to start the initiatives over, they would prefer to partner with regulators in an early phase. Also, they would have liked more standardization across the board; what they encountered was for instance that visors approved by one hospital would not be accepted by another hospital.

The panel also reflected on the special situation during the lockdown, when many people were on furlough and were able to spend their time at will in voluntary projects. The question was raised if people could do that again.

In closing, the panel affirms that they experienced the potential of existing social networks and the power of "seven [sic!] degrees of separation" as one panellist called it, an explosion of getting to know latent talent. The initiatives were able to mobilize talent, bringing in "people with day-jobs solving these problems". They were benefitting from the situation that corporates were often absent, there was "no big chair in the room".

UK update 3 December

The session on 3 December is a follow-up on the 8 July session with the same panelists, Pete Mylon standing in for Kate Hammer representing the CareSleves project. The UK had entered the second lockdown phase on 5 November. The story that the British government had spent 11bn GBP procuring PPE at inflated prices with contracts going to politically well-connected firms, had broken on 18 November (Pegg et al., 2020).

[7] SHIELD stands for Sustainable Hub for Innovation, Execution, Launch and Distribution.

While the local co-hosts kicked off the panel on a rather triumphant note summarizing the earlier panel, participants did not echo that enthusiasm. The demand for PPE from hospitals and frontline workers from makers had declined as the "regular" supply chains recovered. So, makers were looking for purpose in other fields of activity – moving on to other projects, like a bioreactor repurposing PET, 3D printed prosthetics for children, face mask kits for schools, or Perspex separators for restaurants, holders for Covid-19 test tubes. Others were considering pivoting to the global South, for example producing ventilators splitters or setting up the "mask house" at a refugee camp in Jordan where they produced PPE locally, or to develop projects for disaster relief.

There were a few adverse developments – people having less time at their hands when lockdown measures were relieved and other activities restarted, donations from companies declined, makers were unable to claim back VAT. The SHIELD collective, for instance, was stopping their application to become a charity at the last moment. Also, the regulatory environment posed an obstacle, particularly the efforts required to obtain a CE mark – although in one example this was achieved. The conclusion was that for another emergency, earlier and more close contact with the regulator would be beneficial. The same was said about connecting to local groups such as nursing homes, ideally such connection would have been established before the emergency.

The only PPE project with a more positive outlook was Care Sleves. They had provided protective garments for visitors to care homes and were on track to produce their third version of the garment in a small series of 1.000 pieces in the first quarter of 2021. However, this project, too, had had to replace volunteers with university staff.

The panel's overall evaluation of the makers' response to Covid-19 was not purely negative, however. Makers had shown their capability of redesigning objects quickly and effectively. Maker spaces were able to move from prototyping to production to a certain degree, although an increasing complexity of devices could render manufacturing capabilities the limiting factor. However, the nation had to be reminded that "we still have that ability to manufacture things locally". And while makers often were seen as individuals, the overarching makers' response had shown what the "maker movement" was able to accomplish – which hopefully would be a way to attract more government funding in the future.

Common treads and features

The European "Plan C Live" shows were held around the peak of the first wave of Covid-19 infections and related governmental "protection" measures – except for the last follow-up panel in the UK. The sows were created around the narrative that they would be streamed live and were announced accordingly on relevant social media channels. The shows were supposed to last one hour, so the co-hosts tried to cram all the achievements of their panellists into those sixty minutes – ending up both overrunning the hour (which for Zoom sessions and streaming on Facebook was not a particular problem) and cutting presentations and discussions short.

Chaotic beginning, centralized solutions

In all the four countries, the makers' response started on a multitude of communication channels on various social media platforms, and often within only hours or at least a few

days dedicated, centralized platforms were set up to unite makers nationally – not only in the four countries selected for "Plan C Live" shows, bur all across Europe. This was certainly a reflection of the pattern how governments in Europe responded to the pandemic. However, makers tended to organize nationally in Europe long before the pandemic; even the Maker Faire Rome that started in 2013 as the "European edition" in Rome felt more like the "Italian edition" since 2016.

Big numbers

A striking feature of all panels – which I consciously omitted from the summaries above – was an obsession of the panellists with numbers: how many visors they produced, how many tons of filament they used, how quickly injection moulding manufacturers could supply thousands of pieces. The most accentuated example of KPI-ing the makers' response came from Adam Clarke: "8000+ volunteers 3D printed for the NHS & other healthcare workers 185.000+ face shields using 3.000 km of filament enough to stretch from London to Rome and back again, or Edinburgh to Athens, Belfast to Moscow, or Cardiff to Ankara, combined printing time 60+ years in just 10 weeks." Some makers (and their representatives) appeared impressed by the scale they could achieve if working together in large enough numbers – and by the scale of mass manufacturing processes – compared to the solo experience of 3D printing.

Is going industrial necessary or betrayal?

Others, however, were intentionally employing industrial mass manufacturing to scale-up production, intentionally keeping 3D-print capacity for development and prototyping. At least in one panel, the German one, there was a latent disagreement between panellists which strategy would be the "better" or "more acceptable" one for makers as partnering with industry was felt as potentially betraying the "maker ethos" and depriving makers of a much-desired source of income.

Encounter medical world – maker world

A key feature of the makers' response was their involvement with medical professionals – doctors and frontline workers. In many cases they started co-creation activities where makers would develop prototypes of equipment, have doctors or nurses test them and improve the equipment based on their feedback. This was certainly no novelty for design and development of medical equipment, user-centric and co-design being well-established design strategies (Sanders & Stappers, 2008; Stappers et al., 2011). However, for some makers this might have been a new experience, as makers tend to operate "from their own itch" (Raymond, 1999), they "alleviate an everyday need, even if only from the idiosyncratic view of an individual" (Boeva & Troxler, 2021, p. 225). For many of the doctors and nurses, however, the experience of being asked to contribute, to co-design, would most probably have been a new experience as co-design activities supposedly happen almost exclusively at university hospitals.

Transdisciplinary approaches

From the onset of the makers' response the term maker was used liberally – it could equally mean professional 3D printing engineers and 16-year-old bedroom tinkerers. As such, makers came from different disciplinary background. Moreover, makers quickly found that they could not solve all problems in the supply chain themselves. While they were making an impact in designing and sometimes producing equipment, they needed support for

materials supply or for distribution, they used contacts with professional bodies for a wide range of issues from certification to industrial mass production. The makers' response had certainly a transdisciplinary character with face shields and ventilators acting as boundary objects. Transdisciplinary work is supposed to develop from an initial understanding of different perspectives, through the steps of learning from commonalities and differences and of creating connections between different approaches, to instilling broader perspectives on a problem and to create the foundation for new solutions beyond the possibilities and "imagination" of a single discipline (Bakker & Akkerman, 2014; Bargh & Troxler, 2020). Cautiously extrapolating from the second UK panel, it remains doubtful if the transdisciplinary interactions between makers and other disciplines managed to achieve that last stage of founding new solutions beyond the pre-existing disciplinary ones.

Provisionary interpretation

In search for purpose

In all of the panels it was evident that makers were grasping the situation of supply shortages to make a meaningful contribution to society. As mentioned in the French panel, they were eager to move away from the image of "funny guys that make funny things for Maker Faires", to overcome their privileged underdog position of white men spending their free time in manual leisure. In the height of the first lockdowns, the panellists were affirmative and hopeful that this shift had just begun.

However, the list of "Plan C Live" panels tells a slightly different story – topics moving from makers helping the world back to more "internal" issues of re-opening maker spaces and educational activities. Equally, the second UK panel showed that the makers' response – while meaningful and relevant in the first place – did not develop into a lasting new sector of the economy.

Has the transition potential been used?

In the introductory section, I was wondering, if from a transition perspective, producing personal protective equipment for healthcare and related sectors was a novel configuration that could spur radical innovation from its niche into the wider sociotechnical regime. From a theoretical point of view, the makers' response appeared to have the ingredients of a wind of opportunity, a dominant design, an add-on, and a developing niche market. However, at this point – the pandemic being far from over, the healthcare system experiencing substantial strain, 3D printing still growing in applications and makers far from giving up – it is too early to announce the attempt to transition as failed.

Was this an infrastructure project?

I also wondered if producing personal protective equipment for healthcare and related sectors was an infrastructure project. At the onset of the story when people were looking into developing mechanical ventilators, there probably was a potential infrastructure aspect to the makers' endeavours – even if not exactly aligned with healthcare device regulations. So, the route of developing open-source medical devices might still look promising if approached in a transdisciplinary way, working closely with healthcare regulators and professionals. Moving from mechanical ventilators to face masks, however, gives the impression of taking a route of least resistance – which is completely understandable but removed the infrastructure aspect.

Undecided

In conclusion, I remain decidedly ambiguous. The makers' response has brought tremendous help to frontline healthcare workers, quickly and at a moment when they most needed it. Face shields, door openers and ear savers were important parts of PPE that gave professionals the impression of being able to continue to work safely.

However, the makers' response so far was reactive, not proactive. It lacked strategic approaches – and even the most strategically positioned projects were hardly able to leverage that strategic position. This has probably less to do with makers not being able to think, organise and act strategically, it's more likely that their strategy counterparts in healthcare and regulation were not in the mood of experimenting in times of the first peak of a pandemic. However, the way Covid-19 vaccines were developed, tested, and approved might indicate otherwise – except that the parties involved in developing vaccines for sure did not operate from an underdog position.

One thing I will admit: the "movement" part of the "maker movement" probably has been strengthened. Time will tell, if that concerns only the mediated part (as in the shows of "Plan C Live") or if the parties who participated in the wider response – the makers, but also their networks, the small companies, the healthcare institutions – will find ways to continue their cooperation beyond the pandemic. There probably is a huge potential for face-mask-, door-opener-, and ear-saver-like contraptions that have not been invented yet but could become a new kind of healthcare infrastructure in their own right.

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