VIRAL DESIGN

The COVID-19 Crisis as a Global Test Bed for Distributed Design

Edited by **Distributed Design Platform**

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CONTEXT

This is the third in a series of four books developed within the Distributed Design Platform, co-funded by the Creative Europe program of the European Union. Distributed Design allows creatives, designers, makers and innovators to participate in the creation of a new model of production and consumption, in which “bits travel globally, while atoms stay locally”.

The title of the book ‘Viral Design’ is based on Enrico Bassi’s article (FabLab Opendot) which can be found in the final chapter (pp 194-199). The name was inspired by the rapid mobilisation of designers and makers during the crisis. As the virus spread, designs of personal protective equipment (PPE) were globally distributed, designed and produced. Hence, the title ‘Viral Design’.

Preface

How Distributed Design Matters Now More than Ever

Kate Armstrong, Emily Whyman and Paula Sánchez
from Fab Lab Barcelona at IAAC

What a strange world we are living in, but what an opportunity for Distributed Design. Through the Coronavirus Disease 2019 (COVID-19) pandemic 2020 we have seen the rapid decentralisation and diversification of design and production as well as the uptake of maker skills across Europe and the world to meet failing global supply chains and central production systems overwhelmed by unprecedented demand.

Distributed design is one outcome of the intersection of two global trends: the Maker Movement and the digitisation of the design discipline. This convergence has led to the rise of a new market, in which creative individuals have access to digital tools that allow them to design, produce and fabricate products themselves or easily connect to a global network of collaborators to undertake aspects of this process with them. We call this process and the subsequent market which is emerging from these trends, distributed design.

Over six months, we watched the world change around us, as design went viral. Prototyping and digital fabrication spaces filled broken supply chains and local production systems emerged organically with Fab Labs at their centre. Designs for Personal Protective Equipment (PPE) were being shared globally and digitally manufactured at small to medium scale the world over.

The effect of this was personal. The pandemic launched us all into a living laboratory in which our distributed design practices were lived, worked and tested under emergency conditions. Makers and designers turned their homes into live, work and education spaces, taking time to manufacture personal protection equipment from their kitchen tables whilst also schooling children. Others took their design lectures online and our bio-friends were busy sharing recipes for bioplastics over instagram to help make use of increased food waste (and spare time) at home. It seems many of us also discovered our inner budding chefs, experimenting (and sometimes failing) at breadmaking, fermentation and hosting digital dinners with family and friends. These activities helped to get many of us globally to remain strong throughout a hugely intense and unprecedented time. This will remain symbolic for us in many ways for the rest of our lives.

This book collects observations and reflections from the Distributed Design Platform and extended community. It aims to give shape to the experiences of designers and makers across Europe and throughout the globe during the COVID-19 pandemic. As a platform that works through a series of articles, profiles and case studies that explore the role of design and the wider “design world”.

This book compiles 35 contributions from 18 countries across the world. Some articles are a personal reflection, written by multiple authors whereas other articles are more academic. This book was written distributedly during the pandemic, embodying the concepts and discussing the societal and sociological practice of Distributed Design. We hope this book questions, inspires, and emboldens you. You can dip in and out of the different articles, it is not intended to be followed cohesively. Below you will find the question we asked each contributor to answer in their response.

We asked contributors to consider: *the crisis has accelerated distributed design practices. What is the experience of those working in distributed design during this time and how can we learn from this experience for the future?*

Introduction

The DIY and Open Hardware Response to the COVID-19 Crisis

Tomas Diez from Fab Lab Barcelona at IAAC
and Peter Baeck from Nesta

The COVID-19 crisis has brought the world's do-it-yourself (DIY), maker, and open hardware movements into the spotlight. As global supply chains felt short and countries introduced lockdowns, localised community-based production offered alternative routes to design, produce and distribute anything, from ventilators to protective personal equipment and essentials needed for people on the frontline of the fight against the virus.

While the crisis has illustrated the many opportunities in collective intelligence by using new combinations of people and technology and data to tap into our shared capacity to develop solutions to the crisis, it has also highlighted the challenges in getting the design of collective intelligence right. Better collaboration, avoiding duplication of efforts between individual projects and connecting the response of distributed networks with institutions are but a few of these. Below we discuss some of the opportunities in turning to the maker movement when developing different responses to crises such as COVID-19 and the limitations and challenges the recent attention has also brought to the fore.

The Maker Movement Opportunity

The “maker movement” is an incredibly broad term used to describe, in its simplest form, a technology-based DIY culture where people and teams use everything from milling stations and 3D-printers to open-source electronics to tinker, hack and make new tools and products (CCCB Lab, 2013). These range from small hobby projects to developing a large international distributed network of air pollution sensors (Smart Citizen, n.d.). While often based in local makerspaces, it is the use of open-source hardware tools such as Arduino and Rep Raps printers and the ability to share the code behind projects on Github or similar platforms that have enabled the community to grow rapidly in the last decade (Arduino, n.d.), (RepRap, n.d.).

The use of open-source tools and the distributed nature of the movement enables makers to continuously iterate, adapt and learn from shared repositories of tools. This in turn can help reduce the cost and increase the speed of developing new products and solutions to emerging needs or challenges— a feature which has been heralded as an integral part of the future of manufacturing and the fourth industrial revolution.

While no one organisation or network defines the movement, it has to some extent been loosely organised by the global networks of more than 2000 Fab Labs— a type of makerspace that originated from the MIT Center for Bits and Atoms, and since become an international community. This has subsequently evolved to a number of more coordinated initiatives, including cities such as Barcelona setting up public networks of Fab Labs: the international Fab Academy program and the Fab City Global Initiative (Ateneus de Fabricació, n.d.), (Fab Academy, n.d.), (Fab City Global Initiative, n.d.). While there are many commercial opportunities, perhaps the most interesting opportunity lies in how it is changing our ability to solve social challenges in new ways— a field we have studied and supported at Nesta through our work on Digital Social Innovation (Nesta, n.d.).

Globally-connected makers have historically mobilised as a collective movement to develop novel responses to crises. This is facilitated by relatively low cost of hardware; sharing and collaborating on open designs with an international community and spaces for making in local communities. One of the most prominent examples of this is the Safecast project where an international community of makers and developers came together to build open-source geiger counters that local volunteers could use to capture and share data on local radiation levels following the Fukushima nuclear power plant disaster in 2011 (Safecast, n.d.). The mobilisation of the maker community during the COVID-19 was no different— makers designed, adapted, printed and distributed in an unique situation like no other.

Open Hardware Responses to COVID-19

Since the outbreak of COVID-19, there has been a rapid mobilisation of different individual makers and maker communities to respond to the many new challenges posed by the COVID-19 crisis. We can see a sheer volume and diversity of projects— projects such as www.Opensource.com pulled together a helpful shortlist of the different ways people are contributing their skills to support open-source COVID-19 health projects (www.opensource.com, 2020). Other projects used crowdsourcing for Corona maker projects— for example, www.careables.org developed a “Coronavirus Tech Handbook” (Hardware | Coronavirus Tech Handbook | JoeDocs’. n.d).

The many different health-related initiatives can broadly be grouped into those focusing on more complex medical equipment and, simpler yet, much needed personal protective equipment and other tools required for staying safe during the pandemic. As with everything else happening in the world at the moment, this field is changing day by day, so today's list might be outdated tomorrow.

Complex Medical Equipment

The World Health organisation has warned all countries about “optimising the availability of lung ventilation equipment” (CNN, n.d). Alongside governments enlisting the help of major manufacturers like Dyson, Fiat and General Motors, makerspaces are exploring different ways they can support the development of ventilators and other forms of complex medical equipment such as DIY testing kits needed by hospitals (Bloomberg, 2020).

Examples of projects include the open-source Ventilator, a Dublin-based open-source project which was launched to tackle a shortage of ventilators in Ireland and internationally (opensourceVentilator, n.d.). In Milan, at the Institute of Studies for the Integration of Systems, Massimo Temporelli and Fab Lab Milano have developed two projects for local hospitals (Massimo Temporelli, n.d.),(Make in Milano, n.d.). Their first project 3D-printed 100 valves for a local hospital that had run out of supply. The second modified and combined snorkelling equipment with 3D-printed components to create a DIY respirator (dgil.uz, 2020). While the respirator doesn’t have health authority certification, it was found to work on patients and has reportedly been used to ensure nearly 500 patients in northern Italian hospitals have access to life-saving respirators. Similarly, MIT’s CBA alumni Manu Prakash and his lab at Stanford are developing open-source cotton-candy-type machines to make N95 filters for masks (Prakash Lab, n.d.).

Personal Protective Equipment and Other Tools for Keeping Safe

There has been even greater activity in the development of personal PPE and other tools for keeping people safe during the pandemic. This is most likely because the demand for PPE has been even greater and the making of many of these tools are simpler and less risky than some of the more complex medical equipment. One example of this is in the UK. A partnership between Makerversity and Shield enabled the set up of a PPE micro-manufacturing hub for NHS workers to develop sustainable masks, visors and equally critical PPE using 3D-printers and other tools at the maker space (Makerversity, 2020).

'While the crisis has shown the potential in maker solutions, it has also illustrated some of the challenges involved in the sustainability of this opportunity— mainly around collaboration, avoiding duplication of efforts, finding ways of creating collaboration between traditional, institutional responses and those of distributed networks such as the maker movement.'

Similar initiatives to make face masks, shields, gloves, gowns and hand sanitisers are happening all over the world. While some require machines such as 3D-printers, it is important to note that not all making of PPE requires high tech tools. This is best illustrated in how people from all over the world are sewing facemasks for themselves, and for others. We have not only developed PPE. We have designed a number of creative solutions to challenges caused by the pandemic and the need to reduce the risk of transmission. You can now easily find guides for making DIY hands-free door openers, currency disinfection boxes and hands-free sanitiser dispensers (3dprintingmedia, n.d.),(hackster.io,n.d.),(ibid).

Collaboration, Quality Assurance and Ways to Work with Institutions Remains a Challenge

While the crisis has shown the potential in maker solutions, it has also illustrated some of the challenges involved in the sustainability of this opportunity— mainly around collaboration, avoiding duplication of efforts, finding ways of creating collaboration between traditional, institutional responses and those of distributed networks such as the maker movement.

Open-Source Doesn’t Necessarily Lead to Better Collaboration

There are at least 98 different open-source ventilator projects currently happening around the world, each with their own strengths and weaknesses. While open-source means that all projects can be copied, hacked and moderated, the reality is that the field as a whole often lacks structured collaboration between projects. As a result, there is a significant amount of duplication and “reinventing the wheel” taking place which, ultimately, risks slowing down the speed at which products can be developed and put to use. The distributed and global nature of the maker movement and lack of awareness or interest in collaboration with other initiatives is probably the most significant barrier to collaboration. However, there is also risk of a more traditional technology startup competition and a “winner-takes-all” mindset, thus influencing projects and reducing their interest in collaboration. The last challenge for open-source collaboration is related to the exploitation of commercialised resorts, as well as attribution. While open collaboration is at the heart of the communities developing projects collectively that can save lives, there is always the risk for external actors to extract value and commercialise community-led efforts without injecting any value back.

A number of initiatives have been set up specifically to coordinate efforts and resources from makers towards COVID-19 challenges, such as GetusPPE in the US and the HelpfulEngineers open-source group setup by Project Open Air which has more than 3,000+ members looking for different COVID-19 solutions (www.getusppe.org, 2020),(www.app.jogl.io, 2020),(www.projectopenair.org, 2020). Other examples of trying to coordinate international and local efforts include CoronaMakers, Reesistencia in Spain, the French COVID-19 Initiatives network and the Fab Lab Network Open Corona Repository (www.coronavirusmakers.org, 2020), (www.gitlab.com/reesistencia, 2020), (www.covid-initiatives.org, 2020), (www.gitlab.fabcloud.org/pub/project/coronavirus/, 2020). It is a joint effort between the worldwide network of Labs and MIT’s Center for Bits and Atoms, and a tracker for maker resources in cities by the Latin American Network of Fab Labs to enable better coordinated COVID-19 responses.

Quality Assurance and Validation of Designs

The maker movement grew out of a desire for people to hack and modify everyday tools and products at home. Developing medical equipment that could be the difference between life or death is risky and requires a different kind of quality assurance and validation of designs. Most existing projects were still too early-stage to get a sense of the quality and that “a large amount of future work needed to move open-source ventilators up to the level considered scientific-grade equipment” (f1000research, 2020). One example of trying to manage this challenge is the Facebook group, open-source COVID-19 Medical Supplies which has been set up to support the development and quality assurance of open-source emergency medical supplies with contributions from engineers, designers and medical professionals to generate and validate ideas. This has, amongst others, led to the validation of an open-source ventilator developed by collaborators on the group by Ireland’s Health Service Executive (Tech Crunch, 2020). However, much more work is needed to ensure growth / development in quality assurance in the collaboration between crowds of makers and the institution, carers and health professionals they are trying to support.

Scale in Production

Some commentators have described open hardware projects as the “Plan C” for how countries can respond to crisis and the urgent need for medical equipment (Make Zine, 2020). Plan A is governmental takeover of factories through policies such as the “Defense Production Act” in the US and Plan B a commitment by the private sector shifting their manufacturing capacity to producing medical equipment as has been the case with companies such as Fiat and General Motors.

While the maker response strength is fast, agile, distributed and often low cost, one of its biggest challenges is large-scale production. Fab Labs and makerspaces have laser cutters and 3D-printers, however, they are not micro-factories designed for sustained production. Instead of seeing the maker movement solutions as separate to the work done by large-scale manufacturers, these need to be considered as part of a larger, integrated process.

Fab Labs can play a role in making this connection. In Barcelona, for example, an open-source design of face masks improved the production time through moving from 3D-printing to laser cutting. This was shared with a local manufacturer, who could then increase their production capacity from a few dozen to 5,000 masks per day (www.libreguard.care, 2020).

Additionally, maker spaces and on-demand manufacturing can not only pursue production efficiencies solely for profit but can also serve the local needs of people. An inventory of local materials and manufacturing capacity could, for example, serve as a tool for designers, manufacturers and others that play an important role to revitalize local economies, especially after the pandemic.

Copyrights and Patents

At the heart of open hardware and the maker movement is the open-sourcing of designs, meaning everyone is free to copy, hack or moderate existing products. Making the most of the opportunity in making and open hardware within a billion pound market built for medical devices built on patents will continue to cause issues. While the risk of bad PR is likely to be holding back many manufacturers from taking legal action, there have already been reports of some threatening lawsuits against organisations who 3D-print new valves for their ventilators (Tech Dirt, 2020).

Some manufacturers such as Medtronic have taken a more positive approach and made the specifications for their ventilator freely available so that it can be replicated and built by others with the production capacity. Similarly, there have been calls for companies to sign the Open Covid Pledge and for governments to loosen patent law for any products related to COVID-19 and further, ensure the right to repair (www.opencovidpledge.org, 2020), (Bloomberg, 2020). However, in spite of these and other initiatives, a better and more flexible approach to patents and copyright is needed if the maker community is to be more deeply involved in developing and fixing medical equipment.

Supply Chains

Finally, it is important to note that whether made in a factory or makerspace, the making of medical equipment requires materials. While the maker movement has globally spread, supply chains and material-flows of these new production spaces are still tied to industrial principles. Most of the machines are made by existing industries, shipped from overseas. The waste flows are rarely repurposed or reinjected in the local material supplies. Recent projects such as Precious Plastics have opened opportunities to rethink how materials flow in local maker communities, and how by designing interventions in the supply chains and waste streams, we could think about new ways to source materials for local prototypes and production in makerspaces (Precious Plastics, 2020). In a context of limitation of supply chains, as we have seen happen during a pandemic, material sources can be explored at a bioregional level. The current crisis has pushed more creative solutions in the reuse of existing materials, not only at the maker, but also at the industrial level. One example is in the oxygen ventilator in Barcelona, which incorporated windshield cleaner motors in the production line of a car assembler, and then rapidly adjusted their assembly line to respond to the crisis (www.oxygen.protofy.xyz, 2020).

'To build on the opportunities that have been created by the responses to COVID-19 we need to understand how to enable better collaboration within the community itself and how to create the right connections between distributed maker communities and large-scale institutional responses.'

What Next?

As with everything else happening in relation to COVID-19 and it's disruptive effects, it is hard to predict the long-term impact of the recent surge of activity and interest in the maker movement. Will this lead to long-term change in our response to crises, bringing more attention to the idea of creating more resilient and sustainable communities through distributed manufacturing? Or, will it lead to multiple one-off projects that will disappear once the pandemic is (hopefully) over?

To build on the opportunities that have been created by the responses to COVID-19 we need to understand how to enable better collaboration within the community itself and how to create the right connections between distributed maker communities and large-scale institutional responses. The many funders and policy makers who will hopefully turn their attention to the maker movement over the coming months can play their part in this by not just focusing on backing individual projects, but the wider capacity of the community to respond to this and the next crises. Maybe the increase of climate events in the years to come will require even faster and more articulated responses— we are just warming up.

Chapter 02

COLLABORATION AND WAYS TO WORK WITH INSTITUTIONS

How have makers, businesses and policymakers collectively collaborated during the crisis? This chapter contains accounts which are academically-framed responses to the crisis, personal accounts of makers from Denmark and France, and humane, inspiring activities developed to engage children in the darkest moments of the lockdown. Whilst exploring the novelty of social constructs and rapid innovation, the chapter poses questions on the longevity of newly-formed partnerships.

"Collaboration And Ways To Work With Institutions" contains contributions from Massimo Bianchini, Patrizia Bolzan, Stefano Maffei, Michaël Araujo, Soumaya Nader, Quentin Perchais, Asger Nørregård Rasmussen, Stina Sabally, Malte Hertz Jansen and Xavier Domínguez.

Designing in the Post-COVID Era

Transition Artifacts for Distributed Futures

Massimo Bianchini, Patrizia Bolzan and Stefano Maffei
from Polifactory, Department of Design & Politecnico di Milano

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About Innovating between Cycles and Waves

"Cycles" and "waves". These two different words are used to describe a wide variety of phenomena and processes affecting the environment, society, economy, technology, and innovation. Today more than ever, it is important to understand how these mechanisms work, how they are connected to each other and what impact they generate, but also to think about the kind of relationship they have— or may have— with design and production.

A cycle is a series of natural and non-natural events, which repeat in a similar manner, following the same order, during a given period of time. Throughout their evolution, humans have learned to know, reproduce, modify, design and build in an artificial way, both natural and biological cycles. Perhaps this is why we tend to attribute a productive and proactive connotation to cycles, such as agriculture or industrial production.

In contrast, a wave is often the sudden or underestimated flow of one or more climatic, social and economic phenomena with an adverse nature which spills over into a social or territorial context, with a potentially catastrophic impact. In relation to climate change, we hear about heat waves more and more often. The term "wave" is also commonly used to refer to uncontrolled migration flows and the spread of epidemics. Waves stress communities because they modify their economic and productive cycles, making them vulnerable, but also because they require costly investments in preparation to defend or protect themselves, or else they catch them unprepared. Finally, the waves both have a global dimension and a territorial distribution, with local effects and specificities.

Starting from a simple definition, the first step is trying to understand if waves are "objects of change" that influence the birth, the development, and the distribution of innovation cycles. Rising parts of the international scientific community are increasingly reminding us that in the Anthropocene, natural cycles, cycles of human activity, and "wave phenomena" are now definitively interpolated, generating cause-effect dynamics which scale and acceleration can get out of human control and intervention. Researchers such as Timothy Morton define these phenomena as "hyper-objects", i.e. objects whose main characteristic is to exist on space-time dimensions that are too large to be seen or perceived in a direct way (Morton, 2013; 2016). If we assume that it is possible to act on these "hyper-objects" as a starting point, it is also possible to tackle the most interesting elements compatible with the current potential of distributed design and production processes.

'The society we live and operate in is already striving to innovate and produce through virtuous cycles that facilitate the transition to a circular economy model.'

In the field of economic development theories, innovations— especially technological ones— spread in society by cycles and waves. Since the 1920s, scholars like Kondratiev, Schumpeter and Carlota Perez have progressively elaborated and consolidated theories on the existence of long waves (or "super-cycles") of socio-technical revolutions that generate constellations of innovations in several sectors. These long-lasting phenomena follow each other and are characterised both by increasing frequency, speed of development and by a growing impact of socio-economic transformation (Perez, 1983). Carlota Perez has recently highlighted how the COVID-19 crisis fits in the middle of two revolutions, the industrial one and the information technology one. In the same way that some of the businesses that have become more important in our daily lives were born during the Great Recession of 2008-2010, the most emblematic businesses of the next decade could be born from the sudden change in lifestyles due to the pandemic. Given that the neoliberal economy has shown its limits and the pandemic has triggered a rethink about the need and the rules of production management and distribution systems of goods and services in a more global and shared direction, it is important for Perez to understand how the birth of new innovations, or rather the transition to a system based on distributed innovation cycles will happen (Lakhani and Panetta, 2007).

The second step concerns the change of approach and design agency related to distributed innovation. In fact, the society we live and operate in is already striving to innovate and produce through virtuous cycles that facilitate the transition to a circular economy model. This model of circular innovation is developing in a global context that is increasingly facing phenomena with exponential trends that can deflect or favor development trajectories. Bruno Latour (2017) spoke about a continuous mutation of our relationship with the world and a permanent instability in the relationship between nature and culture (scientific, material, design, and production). This means thinking primarily about the evolution of the culture of responsibility and risk in innovation cycles.

In the last few months, the COVID-19 emergency has completely rewritten the agendas of innovators, designers, manufacturers and policymakers by introducing priorities and project themes. Innovating within scenarios in continuous and rapid transformation, transition and mutation requires developing both a design culture of prevention (to limit objective and proven risks) and precaution (to limit potential and uncertain risks).

(Re)Thinking about the Relationship between Distancing and Distribution

The health emergency scenario that has emerged globally since the beginning of 2020 has called into question many of the established socio-economic assets as well as daily practices, habits and lifestyles. From a globalised world— in which the distances between people, cultures, and commodities were cancelled thanks to the logistics networks of people and goods, fed by exchange agreements between nations— the COVID-19 emergency has in fact forced to physically distance itself from people and things. The proxemics of physical and collective relations has been completely overturned, generating a new experience of the concept of spatial and social distance. This type of relationship is rapidly creating a new routine, characterised by the presence of a repertoire of products-services that act on the new and different degrees of separation between individuals and their community or social practices.

This situation has a strong impact on the organisation of different systems:

- It has generated a strong pressure on logistic and goods distribution systems, also contributing to reintroducing the centrality of human subjects and professionals operating in a sector characterised by a massive and extensive technological infrastructure.
- In terms of innovative response, it has accelerated the debate on the potential of distributed production models and of micro and/ or self-production in all its possible organisational and executive structure— from professional and entrepreneurial forms to domestic self-production (DIY).
- It has restored centrality to the organisational models of territorial healthcare in terms of geographical distribution, capillary coverage and medicine of proximity, as well as, social recognition to its operators.

(Re)Thinking the Role of Open Innovation in Contemporary Society

In a short period, we have learned that the new innovative scenario related to COVID-19 requires resilience and speed of design's reconfiguration, production, distribution, and consumption systems to adapt to the evolved and still evolving social needs and habits. But at the same time, it also leads to a shift in the regulation and standardisation system that must verify and authorise it. Hence, on a global scale, there is the emergence of a series of phenomena like the explosion of the need for mass protection products such as masks, protective gloves, visors, and other sanitary materials (before the emergency they were considered commodities), which have shown an unbalanced territorial distribution of entire sectors and production chains. In the past, few countries have concentrated on the production of these products, creating a small monopoly from which speculative phenomena and consequent political-economic tensions have derived.

In response to scarcity in supply chains, some manufacturing companies belonging to different sectors (especially in the textile-fashion sector) have made themselves available to partially and/or temporarily reconvert their production. These companies have then encountered technical difficulties which has slowed down their production capacity. Also regarding the production of life-saving medical equipment, the spread of the pandemic and the consequent lockdown have caused a widespread shortage of materials and components for the production of masks and visors, but also respirators and their maintenance, leading to critical situations in the health care system of the various countries involved. The producers of these goods and their global subcontracting systems have been under great pressure, generating interruptions and intermittence in manufacturing flows.

At the same time, the COVID-19 emergency has revealed on the global scene some real potential of the Maker Movement and of the technologies, places and services for distributed production. For their natural configuration, Fab Labs and Makerspaces are in fact places where you can experiment and produce on-site and on-demand through the tools of digital fabrication. In countries like Italy, France and Spain, characterised by the presence of dozens of geographically distributed and digitally connected laboratories, Makerspaces and Fab Labs have been able to respond promptly to the challenge, activating networks for the design and production of masks, visors, valves and connections for intensive care respirators. It is an interesting fact that more than 30 different models of masks and visors are downloadable from the web and potentially self-producible through 3D-printer, from the beginning of the pandemic until now. Of equal relevance, is the case of the solidarity struggle that engaged the entire community of local makers in northern Italy between March and April to produce large quantities of Charlotte valves in the shortest possible time to convert a simple Easybreath Decathlon snorkeling mask into a potential life-saving garrison to multiply beds in intensive care (Guzzini, 2020).

In the face of this extraordinary global design and production mobilisation, however, not everything worked and there were executive and organisational limits as well as some problems of comparison, regulatory verification and certification. From the executive point of view, the main problem is the impossibility to guarantee quality homogeneous parts production. Moreover, it has not been possible to start an effective control of the output made through 3D-printing which, starting from the same file, can generate parts with very different tolerances, sometimes made by materials not suitable for medical use. As far as the organisational aspect is concerned, the focus shifts to the management of the flow of information, which is crucial in all emergency situations. For several reasons, during the pandemic, it was not possible to structure an official communication channel between maker/Makerspace and local health systems, despite their natural propensity to organise themselves in a network. The difficulty of collecting and managing feedback on the efficiency and necessity of parts and components made it difficult to coordinate and control the distributed production system, which was spontaneously organised. As soon as the industry was able to reorganise itself to face the needs, the whole virtuous network of makers and self-producers was cancelled, as it clearly could not compete in terms of numbers and quality of the products made.

These phenomena, if observed as a whole, outline the partial emergence of a potential ecosystem with an innovative model that we could define as open innovation, based on a more integrated relationship between industrial production, design, and distributed production and policymaking system. An integration between these worlds is possible on the side of experimental research and advanced prototyping, through open design and open manufacturing processes, which can facilitate the definition of common standards for processes and products (and the use of data that supports them). In parallel, there can be a greater union between these worlds with the certification and authorisation system, which is now a substantial part of the innovative development process: in terms of regulations, it is possible to imagine higher transparency and openness of certification processes, while at

the design level it is supported the possibility to access and use open data to configure application scenarios (critical futures), in which to prefigure and test solutions that then have an impact on society (critical making). The result of these scenarios is the creation of a potential field of development of open-source experimental solutions, prepared and validated according to the scenarios considered and the processes tested, ready to be adapted, and materialised according to needs.

(Re)Thinking Nature, Types and Role of Contemporary Artifacts

Latest economic studies report how the first phase of the pandemic generated new and different behaviors in the relationship between individuals, things and environments (Chao, 2020; Karin et al.,2020). The COVID-19 emergency and the consequent lockdown have led people to build new familiarity in the use of devices for personal protection, sanitation, and the measurement of body parameters. The temporary lockdown and reorganisation of food distribution and delivery has meant that domestic food consumption has passed through the rediscovery of individual and family practices of self-production, socially supported and shared through the network. Finally, distance learning and smart working practices have accelerated intergenerational processes of personal and environmental digital capacitation.

At the same time, the shift in the ways of access to services, has accelerated the process of changing the culture of control through systems and devices that operate to scan, track and monitor people's actions and behaviors. All these transformations have already had a direct economic impact in different sectors, triggering reflections on transitions of contemporary society's consumption patterns towards the circular economy. Recent evidence demonstrates the elasticity of bottom-up initiatives by both private companies (e.g. breweries producing disinfection alcohol for medical applications from residue products) and individual citizens (e.g. maker's movements producing mouth masks from textile leftovers and supplying hospitals and care facilities) to recycle locally available resources and thus reduce import dependency.

In response to the need to build local resilience, supply and production systems (as well as associated consumption systems) will likely in the future need to become more localized (Wuyts et al, 2020). Also such legal guidelines would mean that users would not suffer adverse legal consequences when trying to repair products by, for example, fashioning replacement parts using 3D-printing technologies. This shift would help to alleviate durability problems caused by the tendency of manufacturers to design products for premature obsolesce while encouraging greater reuse, recycling, and reclamation of products and components (Hernandez et al., 2020). For distributed design, this means practicing the design of artifacts that are configured as new basics: artifacts designed on new needs and with new standards; artifacts that incorporate new essential functions; tools that help us recover basic skills or develop new ones.

The second theme of reflection concerns the nature of objects developed through distributed design and production processes. The pandemic requires the adaptation of many existing product-service systems, but also the rapid conception of new artifact systems designed in anticipation, preparation or facilitation for the transition from one situation to another and to adapt to the continuous change and adaptation of existing rules, regulations and laws.

Experimenting an Educational Design Experience: Conceiving Solutions for Everyday Life in the Post-COVID Era

Polifactory, the Politecnico di Milano's Fab Lab, during the most difficult days of the lockdown, has chosen to interpret the challenge of the third year of activity of the Distributed Design project focusing on the development of design solutions in response to the habits change and new needs that emerged, both during the sanitary emergency phase and in the following period, making them synergic with the distributed and circular innovation models. The idea of Polifactory is to populate with new solutions the scenario of a "new present", the beginning of a "post-COVID era" in which the watchword is "transition". The epicenter of this transformation starts from the understanding that we live in a world bound by a radical interdependence (Escobar, 2018). All kinds of connections (relational, functional, energetic, emotional) have always characterised the society in which we were born and grew up, and also all the creative imagery and the resulting systems of knowledge, infrastructure, services and artifacts. It is these systems that can and must be redesigned, starting from the things that surround us and that must look at these new times. We are therefore talking about innovative objects for everyday life that not only concern health, but also new needs and activities related to the condition of social distancing and isolation.

Designing Everyday Life in the COVID-19 Era (DELiCE) is the initiative that Polifactory has put in place in 2020 to give shape to new scenarios of everyday life post-COVID, exploring the potential of open and distributed design in the development of ideas. The objective is to prefigure solutions that go beyond the health emergency and remain valid even in the subsequent phase. Polifactory has chosen to launch the DEliCE challenge to 50 young designers of the Concept Design Lab of the School of Design of the Politecnico di Milano (MSc Integrated Product Design). The start-up phase of the Concept Design Lab coincided with that of maximum diffusion of the COVID-19 in Italy. This situation forced designers to experience firsthand the sudden change in their habits, providing them with a unique opportunity to translate, almost in real time, the daily difficulties and limitations into new design opportunities.

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The emerging scenario of post-COVID era has been put in relation with the field of micro and distributed self-production, areas in which the democratisation of digital fabrication allows more subjects to give shape to more artifacts even autonomously, while the simplification and miniaturisation of technologies facilitate the introduction into objects of new ways of interaction, connection and control. Young designers were asked to develop two different solutions by experimenting with two design strategies: on the one hand to create new projects by adopting a maker approach, on the other hand to work on hacking existing objects by modifying their function or field of application.

Through DELiCE, in just two months, 22 concepts were generated: while lingering on some design ingenuity due to the impossibility of prototyping the objects in the conception phase because of the lockdown that has afflicted even the university laboratories, eleven solutions conceived from scratch and eleven hacking projects that constitute a first example of post-COVID era's design biodiversity. The set of these concepts tries to tell some new categories of artifacts representing a first plausible idea of distributed future:

- Artifacts that support a transition to new or different working conditions within domestic and shared spaces. They are add-ons and objects designed to distance without creating social barriers, portable micro-habitats, mobile devices that recreate indoor outdoor environmental conditions, for the comfort of people in isolation (e.g. portable lighting windows that recreate natural light).
- Artifacts that support the reconfiguration of public and (semi-public) submitted spaces to constant changes in terms of rules and behaviour. We are talking about solutions designed for the need of a new way of living social aggregation in safety "colonizing" new empty urban spaces, creating alternative ways for urban mobility, redesigning the distribution of flows of goods and people.

- Artifacts that help people reconfigure and differentiate the same space with different functions. When it is impossible to access spaces other than the domestic one, rethinking leisure time is a theme of design interest. To address this need, it is possible to explore the design of new analog tools and equipment that can be coupled with digital home devices for sports, recreational and cultural activities accessible in a distributed form for individual use.

Of the 22 concepts, four were selected as particularly significant to illustrate the small and large changes in habit caused by COVID-19 and then implemented to become 100% open and distributed. KLAW-4040, Maskering, Must, and Duo are not only innovative solutions that can be easily implemented with the skills and technologies present in makerspaces, but they share an attention to environmental and economic sustainability, the latter aspect not negligible in a moment of global rediscovery of a "digitisable self-sufficiency".

Soon everyone will be able to self-build KLAW-4040, a modular system for the transport of objects designed for private users and professionals that responds to the new needs of social distancing. Masks have become a personal item of daily use for millions of people.

Thanks to Maskering, a silicone support to be worn around the ear together with the mask, it is possible to prevent skin irritation due to prolonged use of PPE, but also to meet the needs of users who have particular ear anatomies or hearing aids.

Finally, when the desire for change also attacks existing objects, solutions such as Must and Duo can take hold through the combination of hacking and digital fabrication techniques. Must is a new low-cost tool for the rapid welding of polymeric materials and fabrics that uses an electric hair straightener thanks to a series of functional add-ons designed ad hoc to allow different techniques and types of joining. In this way, it is possible to create airtight suits or containers for sterilisation.

On the other hand, Duo is a digital device designed to help people with visual impairments to respect the rules of social distancing on the street and in public environments, by intervening both on the white orientation stick and on the harness for guide dogs.

These projects have been designed with the aim of manufacturing with the typical Fab Labs technologies and therefore they can be easily replicated in any of the hubs of this network. Due to that reason, they can be considered as first demonstrators to consolidate the potential of *open and distributed production within the cities*, which is particularly important in the present-day, facing rapidly particular and changing needs.

Acceleration, Transition and Systemic Change. These three words can be the coordinates to define a trajectory of socio-technical innovation in which open and distributed design can play an enabling role. One of the places to trigger this transformation can be precisely the field of design education. Recently, European Commission President Ursula von der Leyen announced her intention to create a new European Bauhaus on the model

of the influential design school. The aim of this action is to create a cultural and sustainable movement in the European Union, "a co-creation space where architects, artists, students, engineers and designers work together". This seems the right space to learn how to co-design a new lifestyle in the post-Covid Era, because a transition from a post-emergency system to an *emergence of systemic opportunities* is already underway!

KLAW, DELiCE Project, 2020

Building a Community in Times of Crisis

Michaël Araujo, Soumaya Nader and Quentin Perchais from Fab City Store.

Communities of makers were quick to mobilise and respond to the needs of healthcare workers during the ongoing global COVID-19 pandemic. This was made possible thanks to the culture of collaborative work, digital fabrication and open knowledge (Fab City Store, 2020). The members of the Fab City Store network were part of this movement in Paris. Makers and designers either participated individually or as part of an initiative, using their skills to develop intelligent designs as a response to the crisis. Makers either provided their expertise through the specifically developed response group named "makerscovid.paris" collective or through the production of content and experiment with their own community (Makers d'Ile-de-France Contre Le COVID-19, 2020).

A Localised Collaboration

In these exceptional circumstances, everyone wanted to contribute to the implementation of a distributed manufacturing network. Despite wanting to contribute, many were unsure of how to contribute— from picking an initiative to help, how to collaborate, how to identify the needs of medical staff. In the face of these unknowns, the Fab City Store network decided to pool together needs, available resources and tools within the collective— www.makerscovid.paris. Below lists a series of opinions, personal experiences and reflections from some of the makers, designers and participants which worked collectively together during the COVID-19.

Quentin Perchais from WoMa was not in Paris during the COVID-19 crisis. He therefore worked on the organisational and logistical setup of the collective: "At the beginning, it was quite simple and basic, with an online spreadsheet we collaborated with the group of close actors that we already formed: Volumes, Woma and Ars Longa. Then, L'Atelier des Amis, Mon Atelier en Ville and SimplonLab, the first labs to mobilise, transmitted part of their operation to the common spreadsheet. Finally, with the increasing demands of the City of Paris and the Salvation Army, we quickly found ourselves growing to around twenty factories to respond to demand and coordinate our actions."

The "makerscovid.paris" collective at Fab City Store, Paris, during COVID-19, Quentin Chevrier 2020.

The organisation was very informal at the start, we supported through phone calls, Facebook and WhatsApp messages. We then gradually began to structure ourselves: "Indeed, we quickly realised that it is necessary to set up a website where the information can be updated almost in real time. We created www.makerscovid.paris. Volunteers then found all the information when they joined here."

At Ars Longa, the members were unable to access the labs and quickly decided to focus on the communication elements to share the actions of the makers. Different communication elements were put in place but they were not sufficient. Thibaut Louvet, Soumaya Nader (Ars Longa) and Quentin (Woma) met on Figma to "homogenise the visual elements already created and to work on a visual identity."

Iterative Dynamics and Manufacturing Protocols

From the beginning of the movement, a great diversity of different models of open-source visors have appeared. These designs come from the hyperactive 3D-printer community on Facebook, Discord and other networks. Yoann Bordes-Pages, designer and Fab Lab manager at WoMa, started prototyping 3D visors at home and then in the Fab Lab. He emphasises the crucial need to iterate the design of the open-source models: "It is a continuous work of experimentation, of adaptation of files to our machines but also to the materials that we have available! At

WoMa, we started production with two 3D-printers, and currently have 9 printers and a laser cutter. We started using it when a resident of Volumes developed a laser cut visor model."

But how can regular citizens be more widely involved in this distributed and united manufacturing action? Outside the Fab Labs, many volunteers were ready to lend a hand to the movement as well. Vincent Guimas, from Ars Longa and Fab City Grand Paris, developed the dynamic factory

at home within the collective: "Everyone at home can participate up to three or twelve hours by receiving kits of visors and mounting them for later distribution. Each location is capable of producing visor kits at the start of the week (pre-cut plates, rubber bands, etc.) which are distributed to the 40 volunteers at home. Once the kits are assembled and packaged, they are delivered to the Fab Labs Fab Labs which serve as distribution points." This reiterates the question of the position of third spaces, which

The "makerscovid.paris" collective at Fab City Store, Paris, during COVID-19, Quentin Chevrier 2020.

in addition to being productive, acts as relays for citizen-makers who print and assemble from their homes! A network of places and actors constitute a distributed manufacturing network at the scale of a district, the city or the metropolis.

Sharing Knowledge Towards Collaborative and Volunteer Initiatives

In her 18m² Paris apartment, which usually overlooks a noisy square, with its metro entrance, cafes, cinema… Hélène Verhelle, the creator of Povera Slowdesign project appreciates the calm (2020). Of course, as a designer, she worries about the future of her brand: "This is the case for many entrepreneurs, it is quite regrettable and I hope that the beautiful social projects that I know will be able to continue!" She volunteers her own craft to fabricate and sew textile masks for working staff with an initiative supported by La Tête dans les Nuages (2020). Faced with the lack of raw material, Hélène even made rubber bands from recycled tights. Inspired by her designer practice, where "she sublimates materials deemed ready to be thrown away" by relying on the recycling of pantyhose in jewelry, Hélène developed elastics with the same technique to counter the shortage in commerce.

On her side, Marie Boussard, designer and illustrator of Maa Design, uses this time of lockdown to join the makerscovid.paris collective, when Villette Makerz got into the loop: "At the Fab Lab, it is the laser that works, we mainly produce protective visors. Things were quickly organised, Damien – resident of Fab Lab – manages orders (requests, deliveries), I manage the machine (production, maintenance) and we manage two (three with reinforcement) the mounting of the visors." That's not all, Marie also created illustrations: "To communicate about our actions, create flyers and illustrate the makerscovid.paris platform." Combining her illustration and design skills, Marie is participating in the development of new solutions to this crisis, such as: "DIY special edition paper masks that can be found free on my site."

Yoann Bordes-Pagè, returns to his personal situation where "in a situation of technical unemployment at the Fab Lab de Woma, I kept an eye on what was being done across France, but also the rest of the world, especially the countries most affected. Seeing initiatives set up on the production of visors, I ordered elastics, rhodoid sheets, and started to test on my personal 3D-printer. I was able to devote myself entirely to this production because, due to the health crisis, my short-term projects relating to my activity as an independent designer were either cancelled or postponed. I still had to make choices and set aside the progress of certain personal projects, considering that the production of protections was more important. In addition, this collective experience resulted in very beautiful things."

Maintaining Activities, but This Time with the Means at Hand

For some designers, the goal was also to maintain the relation with their community during this period of physical distance. This leads to challenging one's own activities and how to engage the public online. Pauline Arnaud and Anna Aflalo from Kutikuti return to the flexibility of their activity which is usually "to design workshops for children, very maker and DIY oriented… During this period when so many parents were at home with their children, it seemed to us more important than ever to continue to offer something to stimulate their brains! Since the start of lockdown, we have therefore offered more than twenty workshops to continue developing our creativity, but also to discover new technical or scientific concepts. Everyone can take stock of the pieces of string, plugs and boxes that fill their house, and prepare for great experiences!"

This approach is in line with Hélène's feedback, who, given her "shattered schedule with what is happening outside", could no longer carry out her workshops physically. So she set up and tested her first online workshop in early April and will be offering more soon. This agility is one of the characteristics of these entrepreneur-makers which means that whatever the situation, they are able, according to Pauline, "to maintain activities, but this time with the means at hand".

There Is No Other Possible Model than Relocated and Distributed Manufacturing

For Michael Araujo, who coordinated the various actions of makerscovid.paris on logistical and political levels with the institutions: "It is important that this cohesion and the wider cooperation continue. This question of a longer-term cooperative model is on everyone's mind, and is also accompanied by questions about the structuring of a local manufacturing model and its economic viability. In reality, the answer that everyone has been able to demonstrate shows that there is no other model than relocated and distributed manufacturing."

It is of course too early to have a clear vision of the future, but the experience of the past few weeks demonstrates the capacity of places, actors and creators of the network to adapt in a situation of crisis, and the real added value of relocation. For the Fab City Store, the role of this mobilisation and this ability to create new models is also to support the creators of the network who all have little visibility on the future of their activities. But also to structure this cooperation so that everyone can share and help each other to resume business. For Hélène, "the rest lies in this union. For the rest, I don't know how to resume my activity, but I have lots of ideas!"

DK Makers Mod Corona ('DK Makers Against Corona')

Asger Nørregård Rasmussen, Stina Sabally and Malte Hertz Jansen
from Underbroen

The potential and importance of distributed design and production has proved its worth during the COVID-19 crisis. When the crisis first hit the world, many societies were locked down and vital healthcare equipment became a scarcity. During this crisis we have seen how global and local networks of makers have mobilised in order to respond to the rising challenges caused by the global pandemic. Within complex networks of makers, universities, companies and civil societies, important solutions to the scarcity of healthcare and protection equipment have been developed and distributed via open-source logics, distributed design and production ecosystems.

The local Facebook group DK Makers Mod Corona was founded in March 2020 by Jonas Damm Hermandsen— a hospital physicist at Region Zealand. The group quickly grew from 50 to 2,500 members, hosting 3D-printing enthusiasts, various makerspaces and Fab Labs, municipal workers, civil society, universities and many more. The group has been focusing on 3D-printing face shields for hospitals and crucial healthcare institutions.

The face shield design builds on top of a design from Spain by Hanoch Hemmerich, which is licensed under the Creative Commons Attribution Licence (Thingiverse, 2020). The original design has been remixed, adapted and shared in order to meet local legislation and needs from Danish hospitals and healthcare workers. Jonas Damm Hermandsen is a hospital physicist at Region Zealand and moreover a dedicated user at Fab Lab RUC (Roskilde University) and 3D-printing enthusiast. The professional knowledge that Jonas Damm Hermansen holds has been crucial for 'DK Makers Mod Corona' to succeed and grow so rapidly. Jonas Damm Hermansen and the administrator group quickly got the required approvals from Region Zealand and a CE dispensation for the face shield design. From thereon the production of face shields began, and design iterations made by the local community of makers (J. Steenbuch Holt, 2020).

3D-printers are in many ways the embodiment of the democratisation of production tools. They can be found in many homes, companies, makerspaces and universities. The technology is still a very slow production method, however, the potential of this lies within the building of community in relation to distribution of design and production— we will return to this later.

From the 1st of March to the 27th of July 2020, more than 19,100 PPE per 1,000,000 populant have been produced and shipped in Denmark. This number puts Denmark within the top four on open-source Medical Supplies' list of Relative Production: Community-Made PPE Per Million Population (OSME, 2020). In Denmark more than 63,000 face shields have been produced and shipped. More than 100,000 face shields have been requested from hospitals and other important health care institutions in Denmark. The initiative is one hundred percent non-profit and, therefore, no face shields can be sold, but only given away for free. The cost for producing one face shield is approximately eight Danish Krone (approximately one euro). The initiative has relied on sponsorships of materials, delivery agreements with postal services and donations. Until now, more than one hundred and six thousand Danish Krones have been donated. The immense support and local demands, as well as media coverage, reflects how collective efforts, non-commercial initiatives and mobilisation of society can benefit the wider good.

The numbers presented here, as well as the story of DK Makers Mod Corona underline the potential of thinking product development and production in alternative ways. Thinking in distributed networks challenges the notion of traditional product protection and patents, and pushes an open-source logic that benefits the commons. In the case of the COVID-19 pandemic, it also benefits the world. It seems obvious that one person with one or two 3D-printers can not "save" the world from a pandemic such as COVID-19, but in the perspective of a distributed network of 3D-printers, the potential unfolds and the production capacity can actually reach an amount that can react to such a large demand that the world has seen during COVID-19.

Jugando con la Luz

Community Art

Xavier Domínguez from Fab Lab Barcelona at IAAC

Introduction

Jugando con la Luz is a globally distributed art installation created by resilient children who live with uncertainty in the situation that is causing the COVID-19. Playing with different sources of light and establishing a new relationship with the materials around them, these young artists invent stories with which they express the emotions and feelings that this new normality provokes in them.

In a short period of six months, what began as a local school project became the revelation installation of the OFF Llum festival and from there one of the proposals selected by Frena la Curva, an international platform that promotes citizen initiatives against the coronavirus based on social innovation and civic resilience in times of pandemic.

With no other ambition than to give people a voice in complicated situations, *Jugando con la Luz* is now a virtual installation that, thanks to the collaboration of the Tinkering Studio of the Exploratorium in San Francisco, can be followed on social networks with the hashtag #LightUpOurDays or on www.jugandoconlaluz.org

Jugando con la Luz is the project dreamt of by anyone interested in education, the design of active learning experiences and the development of inspiring solutions in response to the social challenges we face in these uncertain times. If you also believe that creativity, steAm education (science, technology, engineering, art and mathematics) and learning-by-doing in community are essential ingredients for developing key skills and competences for the 21st-century, please read on because we will not let you down (Yakman, G. 2014), (Dewey, J. 1938), (UNESCO ICT Competency Framework for Teachers - UNESCO Digital Library' n.d.).

How *Jugando con la Luz* Began

It all started on October 5th, 2019 (pre-covid era). Technically, our activities started earlier, when Fab Lab Barcelona at the Institute for Advanced Architecture Catalonia created the Future Learning Unit (FLU) in 2015. FLU is an action-research group whose objective is to accompany people in their personal growth on a creative, technological and social level. We organised a Bioplastics workshop at Maker-Faire Barcelona, October 2019. Maker-Faire is for people who want to learn-by-doing, create and share prototypes made with digital design and manufacturing. At the faire, you can also discover the latest advances in drones, experiment with sustainable and/or reused materials, amongst hundreds of other things.

Bioplastics are a type of plastic derived from organic products such as milk, agar agar, soybean oil, corn or potato starch. On this occasion, we posed a challenge where participants of all ages could manufacture their own as well as prototype possible applications: from moulds to 3D-printed objects with this type of biomaterial. We were proud of our workshop, it reflected that when you provide a common challenge, tools (the maker), content (steAm) and an appropriate methodology (learning-by-doing), you can empower people through creativity and enjoyment.

Jugando con la Luz at OFF Llum Festival, Fab Lab Barcelona, 2020.

One of the groups that participated in the challenge was the Association of Mothers and Fathers (AMPA) of the Sant Martí del Poblenou School. These families were involved in the learning and personal growth of their children, enjoyed and thus experienced first-hand the benefits of steAm education and the maker challenges. We then proceeded to collaborate with the school by transferring the concept of the workshop to a school project. We accepted immediately— a no-brainer. We had motivated people willing to get involved, a school that was determined and open to active learning methodologies and the framework that would facilitate the development and viability of the collaboration, the Do-It initiative (www.doit-europe.net).

Do-it, a Project for Entrepreneurial Development in the Maker World

Do-It (H2020-770063) is a project financed by the European Union and formed by thirteen entities (including Fab Lab Barcelona at the Institute for Advanced Architecture), in which, we investigate how maker education facilitate the development of entrepreneurial skills for young socially innovative people in the open, digital and uncertain world in which we live. As part of this action-research process, we co-design interventions in formal and non-formal educational settings that we then analyse and evaluate with the aim of sharing evidence, learning, methodologies and tools useful to the community.

We were eager to collaborate, but we also had many unknowns to resolve. Who would participate in the project? What can we contribute? What is maker education? How can we use maker education in the classroom to facilitate active learning? How can we empower families, teachers and students? What methodology will we follow to accompany them? Can open and distributed tools help us document the project and then share it with other communities? And, most importantly, what is the biggest challenge that could motivate the whole community (management, families, teachers and students)?

Jugando con la Luz at OFF Llum Festival, Fab Lab Barcelona, 2020.

Designing, Developing and Deploying *Jugando con la Luz*

We co-designed the centre project (intervention) together with the school community over an intense three-week period. We conducted sessions on mutual knowledge, definition of learning objectives, needs analysis and methodology to be followed. During the design process, we found our answer to 'the challenge'. We would participate in the OFF LLUM 2020[1] festival in Poblenou, Barcelona. OFF LLUM is a benchmark event that focuses on experimental light art and on the local proposals of the creation and innovation spaces that form the creative community of Poblenou.

The whole community was highly motivated during the twelve weeks of preparation before the opening of the facility. In teams, the children had to invent and design a story and represent it in a cardboard box using recycled materials and different light sources. We prepared an online

Jugando con la Luz at OFF Llum Festival, Fab Lab Barcelona, 2020.

repository with the methodology to follow, documentation, references, content and didactic guide that the teachers used in the different sessions of experimentation and prototyping with the students.

The Result— an Interactive Light Installation

The result? An installation at Fab Lab Barcelona where a wall of 40 light boxes full of exciting stories illuminated the 3000 attendees who passed by at some point during the festival. It was wonderful to see the happy and proud faces of the students as they felt the recognition of the project and the positive impact on the whole community.

Activating *Jugando con la Luz* During the Lockdown

When you least expect it, life puts us to the test. On 9th March 2020, the Spanish government declared total confinement. This meant thousands of students were no longer able to go to school, many families in Spain were left with a remaining sense of fear and uncertainty. It is in this context that Frena La Curva was created, an international and distributed platform that promotes citizen initiatives against the coronavirus based on social innovation and civic resilience in times of pandemics (www.frenalacurva.net). Laia Sánchez, one of the promoters who knew *Jugando con la Luz*, proposed that we participate in order to give thousands of children at home who were living the situation with a lot of uncertainty the chance to express themselves through art and making.

We already had all the content and methodology designed. So we then focused on making an appeal through social networks so that teachers could use it and apply our methodology locally in their schools as a distance learning maker activity, or so that families could work on emotions and creativity from play and making at home. More than 15 people joined the initiative by adapting the content to families and translating it into other languages (Portuguese, Galician, Spanish and English). The reception on the networks was so great that, to our surprise, the Exploratorium's Tinkering Studio in San Francisco also joined in. The fact that one of the most renowned teams in the world in terms of experimentation and dissemination of steAm decided to join the call gave us a boost of energy. It was very easy to coordinate with them and transform Playing with Light into a virtual installation that can be followed on social networks with the hashtag #LightUpOurDays or on www.jugandoconlaluz.org. So far we have received over 500 proposals from 10 different countries and over 200,000 interactions on social networks. It has been a pleasure to explain how what started out as a simple idea has become a project for everyone. This is due to the open and distributed knowledge and involvement of the creative community around the world. Long live *Jugando con la Luz*!

Chapter 03

PERSONAL PROTECTIVE EQUIPMENT AND OTHER TOOLS FOR KEEPING SAFE

There has been even greater activity in the development of personal Personal Protective Equipment (PPE) and other tools for keeping people safe during the pandemic. This chapter illustrates a number of creative solutions to challenges caused by the pandemic and the need to reduce the risk of transmission. This chapter covers the winner of the category ‘Design for Emergency’ for this year’s Distributed Design Awards and texts on PPE which have been exhibited at this year’s Vienna Design Week. This chapter narrates the story behind each mask, from the amount of masks produced to a more abstract reflection on the cultural landscapes behind each mask.

“Personal Protective Equipment And Other Tools For Keeping Safe” contains contributions from Emily Whyman, Hannah Grogan, Máire Kane, Réka Vikárius, Ádám Miklósi, Ryota Kamio, Josh Feng, Gabriel Roland, Alfonso Parra Rubio, Nawres Arif Abdulwahid Naser, Isac Filho, Juliana Rabello, Ricardo Ruiz, Julien Vaissieres, Milo Mcloughlin-Greening, Anool Mahidharia, Narender Sharma, Vaibhav Chhabra, Ondřej Veverka and Tomáš Kroutil.

Personal Patient Pack, a Winning Design

Presenting the Distributed Design Awards 'Design for Emergency' Category Winner 2020

Emily Whyman from Fab Lab Barcelona at IAAC

This is a case study about the winners of the “Design for Emergency” in the Distributed Design Awards 2020— Hannah Grogan and Máire Kane with their Personal Patient Pack. The third edition of the Distributed Design Awards contained six different categories. The categories were: Future Thinking, Cultural Significance, Circular Design, Adaptable and Open Design, Sustainable Production and Design for Emergency. Hannah and Máire have a design interest and professional experience in redesigning medical equipment for hospitals with sustainability in mind. The Personal Patient Pack reimagines health and emergency care in hospitals, factoring in the circular economy in the design process. This design allows medical equipment and digital records to travel with the patient, reducing the overall single-use plastic waste produced by sixty-seven percent per case.

How Do We Design for Emergency?

From previous experience working in medical design firms, Hannah and Máire became actively aware of how medical devices are most commonly designed without the vision of sustainability in mind. The pair recognised an opportunity in the redesign of healthcare, in which design can play a role in factoring in sustainability, whilst medical professionals can remain focussed on the most important goal — the health of the patient.

“Saving a patient's life comes first over the sustainability of medical devices being used.” (taken from an interview by Hannah and Máire with a healthcare nurse in Dublin).

This design aims to target healthcare bodies and instigate more sustainable choices and options to create positive environmental change in the realm of emergency medical care. Hannah and Máire began the project with the initial aim of applying circular design principles to emergency medical care. During their research, it became evident that an airway management scenario produces a large amount of clinical waste. This waste majorly consists of single-use devices which are then sent for incineration.

In the event of an emergency— such as a stroke, cardiac arrest or a heart attack, a single patient can use up to four delivery masks, four bag valve masks, two nasal cannulas and two pairs of scissors. The cost of disposing of these items is one thousand euros more than disposing of recyclable waste. For these reasons, the pair designed the Personal Patient Pack.

The Winning Design— the Personal Patient Pack

The Personal Patient Pack (PPP) is designed to move with the patient between areas, so that the equipment safely travels with the patient, rather than new equipment being used and thrown away each time. This reduces single-use waste by sixty-seven percent per patient.

The PPP is made from a polycotton material with embroidery labelling which has the potential to be laundered for over 100 cycles. The design can be produced without adhesives or plastics, which means that the pack can easily be disassembled and recycled at the end of its lifecycle.

The pack is designed for airway management use— it holds a resuscitation device consisting of a delivery mask, a bag valve mask, scissors and a nasal cannula— the products which were recognised as producing the most waste during their lifecycle. Further, the PPP is equipped with radio-frequency identification (RFID) technology, which can hold a digital patient medical record and allows for traceability at all times. This design specifically concerns that of holding emergency airway management equipment, however, the concept of keeping products with their patients throughout their hospital visit could also be used as a model in other areas of care, for example, with the bed linen.

Why Responsible Design is Crucial for Healthcare

Hannah and Máire involved healthcare professionals in the iterative design stages of the process, balancing design development work in the studio and conducting interviews with healthcare professionals, researchers and experts in the field of the circular economy. The product has been designed with the user in mind throughout the process. The PPP can be instantly recognised by medical professionals as a respiratory care pack— this indicator can create a more efficient journey. During an interview with

Personal Patient Pack, Hannah Grogan and Máire Kane, Ireland, 2020.

a paramedic based in Dublin, the paramedic commented:

"This PPP instantly tells me two things:

- The patient has pre-assembled devices,
- This patient has previously had a respiratory arrest or is at risk."

In initial discussions, the Head of Procurement and Infection control from St.James' Hospital, Ireland advised the design to be made from white polycotton fabric to ensure easy recognition of dirt. In further interviews with nurses, it was suggested that this design could be used in tracheostomy care, reflecting on the utility of the design across different medical fields.

Reimagining Healthcare with the Circular Economy

The design of the PPP highlights how design can facilitate and introduce sustainable perspectives into the medical industry. Design perspectives allow medical professionals to keep the health of the patient as their first priority, whilst intelligently designed equipment and services can promote sustainable practices and closed-loop cycles.

There are four key areas in which this product can offer solutions. Hospitals and ambulance services will economically benefit from the reduction in the volume of clinical waste sent for incineration. The lifecycle of the products are hugely extended— this pack remains with the patient, which means that the products and materials are utilised to the maximum until the end of the patient's healthcare journey. Digitalising patients records can make for more streamlined service and ensure the data is kept with the patient at all times.

The PPP has sparked wider conversations of how circular economy principles can be integrated into healthcare systems. In 2019, Hannah and Máire were invited to the Ellen MacArthur Foundation on the Isle of Wight to present the PPP at the Disruptive Innovation Festival. This design has now been selected as the winner of the Distributed Design "Design for Emergency" Award 2020.

The PPP embodies the principles of Distributed Design. The pack includes the users throughout the design process and acknowledges the much wider scope of the product life cycle and how this fits into hospital supply chains. The design is sensitive and coherent for medical users, acknowledging the potential for further scope in other areas of healthcare and medical design whilst ensuring the health of the patient but also, the health of the planet in the process.

We Interviewed the Designers Behind the Winning Project

Can you describe the personal patient pack in one sentence?

The 'Personal Patient Pack' is a product service system which allows single use devices to follow the patient throughout their healthcare journey and on average, reduces waste by 67%.

Why do you think your design field matters now more than ever?

During the COVID-19 pandemic, we have realised how crucial medical device design really is. This is evident with open source projects like the Open Sourced Ventilator project (OSV) in Ireland. As designers, we are used to working in teams to solve problems whilst reaching out to others who know more. As medical device Designers, we have learned to think in a proactive, creative manner while complying with regulations, market needs, user needs and key insights.

The design and development of a medical device is the most crucial phase for its success. From recently finishing an MSc in Medical device design we realise that a loosely defined medical device, will not make it to market.

How has COVID-19 affected, shaped, or evolved your practice?

With the recent lockdown, we have learned to work from home freely on our own. For our final Masters projects, both projects completed by Máire and Hannah were tackling the challenge of helping to overcome the pandemic from the healthcare perspective. We had no choice but to learn how to design in and for a crisis environment. Being able to connect via video calls has been an amazing resource for us and meant that we could interact with people who may not have agreed / had time to meet in person.

Why is it so important that we put sustainability in the line of thinking when we design medical healthcare devices?

There are many sectors where product life extension can be a challenge, such as for some products in the healthcare sector, where infection control is a priority. Recycling or incineration is currently a go - to solution – making the chances of contamination low.

If sustainability design principles are implemented at an early stage in the medical device development, it can really solve huge sustainability issues at the user end. Medical device designers have the responsibility to know how to design for sustainability and to always question how products are currently being designed, manufactured and implemented. It is vitally important that this teaching is brought into the university level education system, so this mindset is instilled at an early stage in one's career.

'Being young, female entrepreneurs in the medical device design field is relatively unheard of. We have the ability to approach problems in a new and creative way by pushing the boundaries of what's possible. This project has shown us that if we put our minds to it, we can really make a change in the sector so this is only the beginning for us.'

The Personal Patient Pack utilises this thinking and highlights that when coordinated with already-existing cleaning systems, it is possible to re-design single use healthcare products into multi-use ones, reducing the amount of waste produced per patient or treatment.

What's next for your design practice?

Designing for the circular economy is a complex phenomenon which requires the adaptation of existing systems and the implementation of new ones. It is so important to look holistically at these sustainability problems in order to make real change in the area.

Being young, female entrepreneurs in the medical device design field is relatively unheard of. We have the ability to approach problems in a new and creative way by pushing the boundaries of what's possible. This project has shown us that if we put our minds to it, we can really make a change in the sector so this is only the beginning for us.

In our experience to date, Máire and I have learned that some medical design companies can sometimes on occasion, lack the personal understanding required to design for a specific need. It is time to consider the minorities in our society by implementing solutions through design! The process of engaging with users and uncovering their life struggles can be challenging on many levels but especially when finding a way to positively impact their life, it can be the most rewarding and satisfying feeling! Being able to apply this empathy in our careers is one of our core values as designers.

The Story behind the SIMPLE Face Shield

Designing a Fully Open-Source Personal Protective Equipment

Réka Vikárius from FabLab Budapest with contributions from Ádám Miklósi

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As a result of the pandemic, many designers and makers around the world have felt that they cannot sit idly by and would like to contribute to the fight against the virus with their creative ideas and knowledge. One of the biggest problems has been the lack of protective gear and equipment for healthcare workers and staff.

In addition to responsible design, the creation of the face shield named SIMPLE also stemmed from personal motivation. Industrial designer, Ádám Miklósi has several doctors and healthcare workers among his family and close friends who have been directly involved: “I felt that I wanted to help them to the best of my knowledge and contribute to the defense as a designer” – Ádám emphasised. This is how the story of the cheap face shield that can be produced in high volume began.

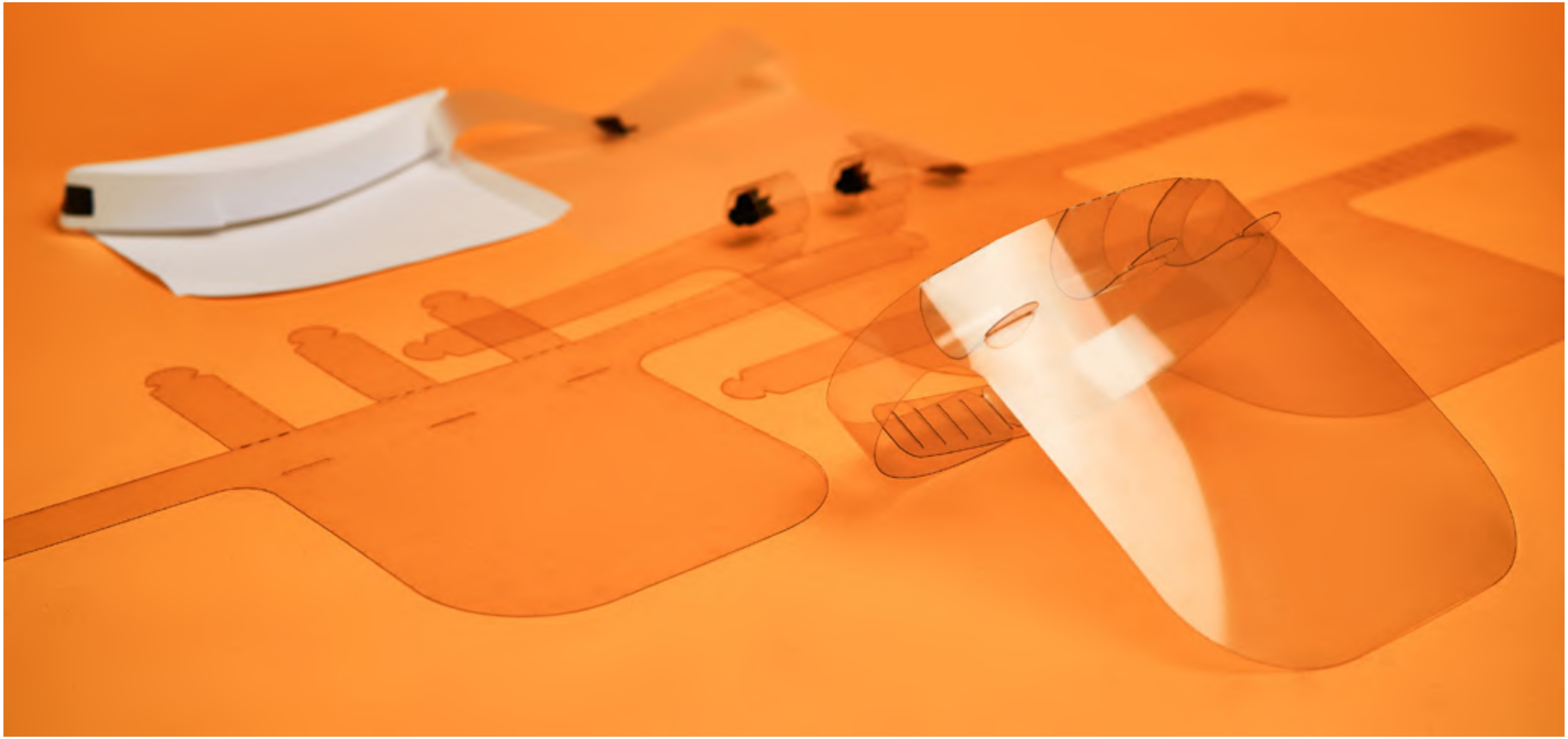
Emergency Meets Design

Factors and Fundamental Problems Influencing the Design of the SIMPLE Face Shield

In a relatively short period of time, 3D-printing communities around the world have become a major driving force in the production of various types of alternative protective equipment. Although the initiative has been remarkable (an example to follow), the production process with regard to the final product has not proven to be sustainable. The main sources of inspiration for the design of the SIMPLE Face Shield have also been the face shields created with 3D-printing.

But what does a face shield made with 3D technology look like and what are its disadvantages? These types of face shields usually consist of a 3D-printed strap and a snap-on transparent plastic (PET) sheet, and the adjustability of the device is achieved by attaching a rubber strap. Due to the technology, production and assembly proves to be an extremely time-consuming process (approximately three hours/piece), to which we have to add the time of cleaning and logistics. Considering cost, production is not optimal in terms of either raw materials and machine hourly rates or assembly work. A further disadvantage is that the shields have to be delivered in their assembled state, which proves to be a less space-saving solution during transport.

The SIMPLE Face Shield, Kevin Campean, 2020.



The SIMPLE Face Shield, Kevin Campean, 2020.

Thus, by eliminating the above flaws, the goal was to develop a face shield that could be produced and assembled in large quantities and in the shortest possible time. The consideration of these factors has largely determined both the design and the use of materials for the protective equipment.

"I definitely wanted to create a tool that could be made from a single raw material and a single spread. In the first round, I created a dummy consisting of a sheet of paper and a paper strap. Then, in the workshop of FabLab Budapest, we made the first testable prototype from a PET sheet with a laser cutter. We had mixed experiences about the results, as this design still fitted directly to the forehead and fogged up during use. Recognising the importance of airflow, I designed retractable tabs for the spread and after two or three re-iterations, the first perfectly functional and testable version was completed" – said Ádám about the steps of the shield's design process.

However, during the preparation of the prototype it turned out that the production of a shield consisting of a single spread results in a larger amount of waste. Thus, the next question was how to optimise the amount of waste generated during production without the end product having a negative impact on the quick assembly process, this being one of the most important factors in user experience.

Becoming Fully Open-source

The Advantages of Co-creation

The further development of the SIMPLE Face Shield, made of one spread and the use of one PET sheet with laser cutting technique, entered the next stage. Ádám felt his first version was adequately developed to make it public, so he created a project page for it in the Wikifactory database. As the designer recounts, this led to further results:

“During the production of the prototype, it became clear to me that the dieline had to be optimised to reduce the waste generated. I thought I would make use of the possibility of co-creation through open-source design to solve this problem, and looked for designers to help optimise production.”

Soon more people joined the project, like Joe Graves, Nicholas Nawa, Theo Davies, and Herminio Menchaca, who all suggested better and better versions and modifications. These versions were characterised by breaking the product down into several components and nesting the parts on the raw material of a given size. Two-, four- and five-part face shield types were made: typically, the more components the construction was divided into, the more economical and waste-friendly production was achieved.

Strengths

Can be produced quickly, with a short production time: 30,000-100,000 pcs/day

Can be assembled in a short time: ten seconds

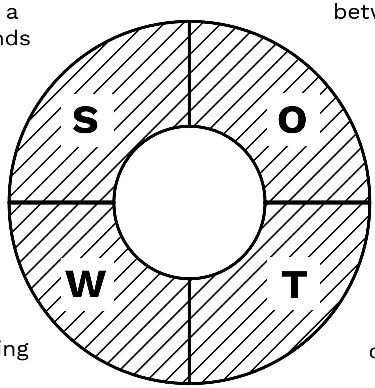
Space-saving: flat-pack, easy to store

Recyclable

Opportunities

Reduction of production waste

Finding the optimal balance between user experience and waste volume



Weaknesses

The amount of waste generated during production

Threats

The negative impact of waste reduction on user experience

The SIMPLE Face Shield in use, 2020.

SIMPLE Face Shield in Use

Validating the Product

The next important step was the validation of the face shield. The designer approached local hospitals where medical staff and doctors could test the protective equipment. The shields tested included one-, two- and five-piece versions. During the validation, the aim was not only to assess the advantages and disadvantages of the different types, but also to test the cleanability and reusability of the product according to the hospital protocol.The reception of the shield was extremely positive and, as it was a product in short supply, each institution wanted to request a larger quantity as soon as possible.

A few user opinions:

“The shield was very comfortable during use and did not press on the forehead. It performed its function excellently!” (Dr. Erzsébet Veress)

“The SIMPLE Face Shield can be easily attached to a surgical headlamp, so it can also be used in otolaryngology.” (Dr. Edit Síró)

In terms of variants, based on the feedback, the one-piece, collapsible version was clearly the most preferred version: multi-component types started causing difficulties, as individual components were mixed, and also, the stability of the device was reduced when worn.

“Product development came to a crossroad: I had to decide whether I wanted to start production by concentrating on the economical use of the raw material or a better user experience” – Ádám emphasized. “Due to the urgency and necessity of the situation, I opted for the one-piece version. I found it more important that the tool be easy and simple to use. Furthermore, it being a PET material, the waste generated during production can be fully recycled and made into another face shield” – he continued.

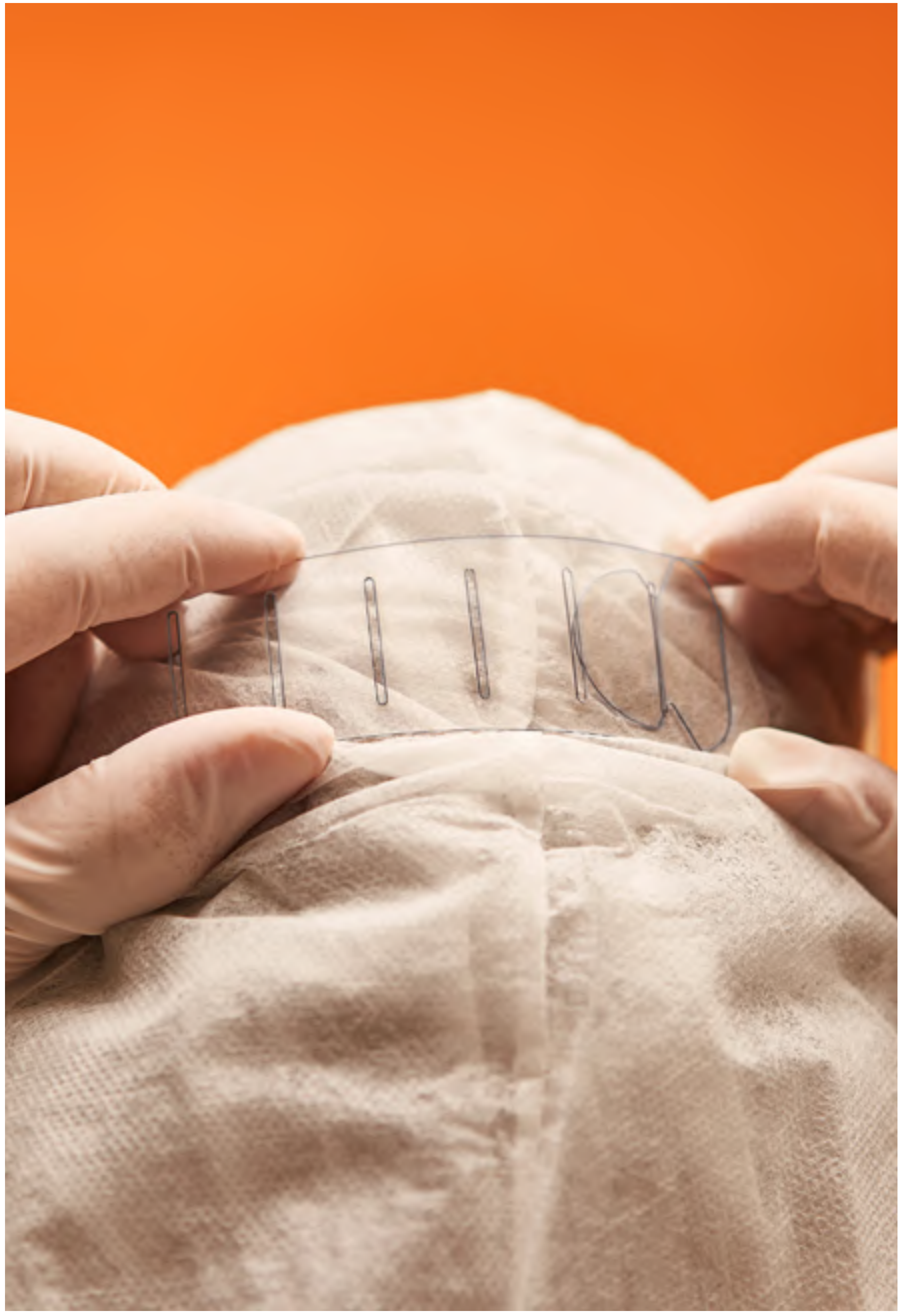
During the consultation with the doctors, a lot of useful insights were obtained regarding the size of the shield and other practical problems, which were eliminated, and the V2 version of the SIMPLE Face Shield was created.

Implementation of SIMPLE Face Shields Across the World

After the validation of the product, documentation was prepared on the face shield in its final form, and Ádám updated the Wikifactory page with the new production files. After that he posted a message on Facebook looking for collaborating partners to manufacture and finance the product. Soon, dozens of volunteers with the aim to help came in, and the production and delivery of SIMPLE Face Shields began to institutions in need. As a result of the work of various self-organizing communities, the product has reached many countries, including Mexico, Columbia, the United States, Portugal, and England.

The Outcome in Numbers

The SIMPLE Face Shield is a product that started out as a voluntary project and can be produced in large numbers cheaply and in a short time, has helped many people. Up until now, the face shield design has been downloaded by approximately 100 volunteers, and about 10,000 pieces of the protective equipment were donated worldwide. In Hungary, approximately 5,000 donations were made to various healthcare institutions.



The SIMPLE Face Shield, Kevin Campean, 2020.

UNA Laboratories

Reimagining Travel, Connecting Nativespaces

Josh Feng from UNA Laboratories

In a world changed by COVID-19, it is more necessary than ever to reconsider traditional models of tourism. As a travel design firm, UNA Laboratories works to create experiences that integrate creation, knowledge, and community — rooted in regionality but not bound to it. In April, we began creating masks with Kurume Kasuri, a traditional cotton ikat textile from the Chikugo region of Kyushu, the southernmost island of the main Japanese archipelago. Though this fabric has been made in Japan for centuries, the Chikugo region is the last self-sustaining cotton Kasuri production region in the country.

These masks are but one reinterpretation of this fabric, one that continues to evolve with modern times. Take for example MONPE, Kurume Kasuri farmworking pants made with a modern update by Unagi no Nedoko, a Kyushu-Chikugo regional trading shop and UNA Laboratories partner. From textiles to ceramics, lanterns to chopsticks, Kyushu is home to a wealth of diverse craft-making traditions. The tactility of objects themselves reflects a constellation of maker, landscape, and tradition. But beyond the physicality of things, UNA Laboratories explores the experiential realm that shapes the context of craft and object.

There is a movement in Japan that, on its surface, champions the “locality” of rural areas in contrast to the Tokyo and Osaka megalopolises. While this movement directly borrows the English word “local” in its name, the term simply becomes a placeholder for rural, countryside, or regional. This movement highlights the unique characteristics and attractions of regional culture, but it also works to commodify and flatten them.

“UNA stands for United Native Acumen. For us, we conceptualise the local through ‘nativescapes’ — the dynamic cultural landscapes amongst which people live.”

Neither a locality defined in opposition to the urban, nor a nativeness that simply isolates regional difference, nativescapes are intertwined with the collective histories of lands, current ways of life, and creation of sustainable futures.

Shimogawa Textile, Yame, Fukuoka Prefecture, Japan, 2019. Koichiro Fujimoto©

What Does this Mean in Practice?

As an entry point and guide, we publish a magazine called TRAVEL UNA semi-annually — each issue takes a deeper look into Kyushu’s culture via different themes. The first issue focuses on textiles, particularly Kurume Kasuri. The recently released second issue takes a look at rice, not just as a staple grain of the Japanese diet but through its many transformations (i.e. sake and sweets) and connections to Kyushu’s history and culture (i.e. Shinto religious shimenawa ropes and craft-making traditions). From here we take an immersive approach to travel, one that brings people from other communities and countries to meet makers, learn about traditions, and exchange ideas through co-creation.

This process nurtures new and alternative forms of knowledge that benefit both visitors and those who welcome them. In this way, we can consider the evolution of culture moving forward to not just preserve regional cultures and traditions, but to invigorate adaptable systems of learning and craft — to spark a living dialogue. Masks made from Kurume Kasuri are but one of many branches of discovery. Through the explorations that stem from these starting points, we can connect nativescapes, learn from each other, and create more resilient communities.

Local Response, Global Need

Design Responses to Shield Masks

Gabriel Roland from Vienna Design Week

Introduction

Resilience is often cited as a key quality in the successful response to COVID-19. The reasoning goes that organisations, cities and societies whose processes retain their ability to function more or less normally under pressure are the ones leading the way through the crisis. While there is definitely something to be said for a certain cosy feeling of normality and for the security of established systems, the pandemic has rendered many tried and tested approaches ineffective or untenable. COVID-19's wake swept away logistical frameworks, which were regarded as solid beyond doubt, and made the inequalities of our societies even more grossly obvious than they were before. In general, the situation made many of the methods and systems that we were and are used to look exactly like they are: old, inflexible, brittle.

So, in addition to making valued concepts resilient, a second set of methodologies makes itself available in times of crisis: flexibility. The radical transformation of circumstances invariably validates some operating procedures, just as it weeds out others. Ideas that have been waiting in the wings of history, and which might not even be exactly new to experts and enthusiasts anymore, are suddenly propelled to a place of public awareness by favourable winds of change. More often than not this happens as a result of forward- thinking activists who wield the results of these progressive ideas as they step into a breach left behind by the collapse of one or the other old concept. When you see it like that, the act of taking responsibility, as something that is usually associated with resilience, can also come naturally with being flexible.

An example for a— you could call it a toolbox— is the constellation of maker movement, distributed design and manufacture and open-source thinking. During the emergence of the COVID-19 pandemic, it quickly became apparent that these combined ecosystems were something of a sleeping giant. By leveraging networks that have been underestimated thus far, through the courageous efforts of individuals as well as collectives and aided by technologies that have steadily progressed from hobby to home industry, its globally distributed limbs started to move in a coordinated way— and to produce protective equipment for hard-pressed frontline workers all over the world. Applying said toolkit, combined with a healthy dose of improvisation and ingenuity, designers and makers began to act as part of a network which is as informal as it is wide-ranging. They began to respond locally to a global need.

To portray such a multifaceted and asymmetrical development to a collaborative approach seemed like the only option. In conversations between the European Distributed Design Platform, its Viennese member institution Happylab, and Vienna Design Week, the idea grew to capture this moment by producing an exhibition around a few examples of protective face shields. The exhibition was designed to take the objects which, while seemingly identical, exemplify a whole array of ingenious problem-solving techniques, as a starting point to telling the stories around their conception and production to contextualise them as uniquely localised parts of a global movement. In itself, the exhibition also demonstrates how a collaborative initiative of an international network (DDMP collecting designs from all over the world), a local producer (Happylab manufacturing the objects), and a curated presentation platform (Vienna Design Week premiering the exhibition) can create a multilayered benefit. Ultimately, the project aims to highlight how communities of designers and makers have found their own ways of assuming responsibility in the crisis and how open-sourcing, decentralised production and democratic design can come together to protect us.

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Comparing Design COVID-19 Responses to PPE Masks

Emily Whyman from Fab Lab Barcelona at IAAC

Alfonso Parra Rubio — MIT Center for Bits and Atoms (US)

The People behind the Project

The design of this PPE comes from Alfonso Parra Rubio from MIT's Centre for Bits and Atoms (CBA). Aiming to produce a design to be replicated by anyone, anywhere, the Curved Face Shield was inspired by Japanese Kirigami (folding) approaches. The design was developed working with Boston Medical Centre and the MIT COVID response team to meet the urgent need for PPE in hospitals, in which quantity and rapid production speeds are crucial to meet demand.

Distributedly Designed

There are different ways of producing this shield— with a knife cutter, laser cutter, die cutter, stack CNC-milled and more. The shields were developed and iterated within the MIT COVID response team and Boston Medical Centre (BMC), in which an empathetic attitude and continuous user feedback provided was key to the design process. Shields were delivered through conventional channels and a few deliveries by Alfonso on his bike.

The Hard Facts

This shield is made of two materials— one transparent plastic sheet (PETG) with a thickness between 0.3mm— 1mm and one rubber band. The project has been funded by Alfonso's work at the MIT CBA. The shields that were produced at MIT were made using a Zund Digital Cutter.

Sending Bits, not Atoms

Fully open-source and costing less than one dollar and fifty cents, these shield designs have been used globally, from Mexico to Spain. The design is flexible for those who do not have access to a 3D-printer but require rapid and batch manufacturing. This project has led to the collaboration of MIT CBA and BMC for an even more ambitious project.

Alfonso Parra, US, 2020.

Nawres Arif Abdulwahid Naser — Science Camp (Iraq)

The People behind the Project

This mask was voluntarily designed collaboratively by a Careables community in Iraq and received a high demand from medical staff. Local activists, volunteers, academia, local government, manufacturers and the Careables team co-created this PPE mask using raw materials from a local manufacturer. Key learnings from this project reflect many other co-design practices developed across the world as a response to COVID-19— the importance of capacity building, teamwork, design thinking and forward planning.

Distributedly Designed

This mask was produced using iterative steps in which each design received user feedback via an online form which then allowed for modifications. The masks were sent to medical staff, policemen, delivery and other essential service workers using academic and governmental authorised vehicles to transport the masks from producer to user.

The Hard Facts

The mask is made from PET sheets and fabricated 30mm elastic bands using digital fabrication using a CO2 laser CNC. The mask can be assembled by hand, through threading the elastic through the laser-cut slots. 13,000 masks for six cities were produced by volunteers sending masks to six cities in Iraq.

Sending Bits, not Atoms

The mask is completely open-source and can be found online. This project relied solely on volunteers but it has been recognised that, with governmental support and funding, the project could have met the national need of 266,000 masks distributed to eighteen cities.

Science Camp, Iraq, 2020.

Isac Filho, Juliana Rabello, Ricardo Ruiz — Casa Criatura (Brazil)

The People behind the Project

Careables (Brazil) already develops projects within the field of healthcare and digital fabrication. Therefore, designing PPE for the COVID-19 crisis naturally became the focal point for a collaboration between three product designers and two handcraft artists in Casa Criatura makerspace.

Distributedly Designed

The masks were donated and sold to health sector professionals from Olinda, Caruaru and Recife, donated to NGOs Campesino Landless Movement and Architects for Solidarity, donated to Indigenous Health Authorities in the states of Pernambuco, Bahia, Paraíba and the Amazonas, and also, to key workers in supermarkets and delivering goods. The masks were delivered via the Brazilian Air Force, common postal services, personal deliveries and collective distribution to rural communities.

The Hard Facts

5,000 units were produced using the materials of PS, PETG, 0.3mm acrylic crystal and an elastic strap. They are fabricated using a laser cutter and stapler. The PPE is an adapted design of the b=Bauhaus model, the Science Camp (Iraq) model, and a local design from Careables. The project initially received funding from Careables.

Sending Bits, not Atoms

The PPE is open-source, but it can also be purchased at three euros to support the sustainability of the Casa Criatura makerspace. The masks illustrate how the logistics of Industry 4.0 facilitate effective work practices, with testing and prototyping with health authorities from Olinda and the director board from the ICU from Agamenon Magalhães in Recife.

Casa Criatura, Brazil, 2020.

Julien Vaissieres, Milo Mcloughlin-Greening — Batch.works (UK)

The People behind the Project

Batch.works is based in London, UK. Before the COVID-19 crisis, Batch.works designed and produced bespoke 3D-printed products, from lighting to vases. At the beginning of the lockdown Milo and Julien proactively made the decision to switch to manufacturing face shields. The initial design sprint for the Batch.shield project was a collaborative effort between Julien and Milo, working on the ground at Batch.works. Salome Bezin worked remotely on communication with procurement departments.

Distributedly Designed

After crowdfunding fifteen thousand pounds, Batch.works and a group of dedicated volunteers produced over 10,000 face shields for the St Bartholomew's Hospital Trust in London. The design was produced in collaboration involving hospital procurement departments and end user feedback, receiving a large demand for the shields.

The Hard Facts

The 3D-printed headband of the mask is made from recycled PET and the visor from PET. Due to a high demand for PET, it was noted that it was difficult to source. Batch.works have produced more than one design for PPE— this design was custom made for St Bartholomew's Hospital to cater for their specific needs.

Sending Bits, not Atoms

Over the past three years, Batch.works has developed specialised small-scale batch manufacturing facilities and technology. Due to the unique 3D-printer setup requirements of the modified Prusa MK3S and laser cutter, this shield is not open-source. It is, however, developed from parts that allows for customisation and potentially extended product life. The visors were delivered via bicycle and directly by their partner — Padelme.

Batch.works, UK, 2020.

Anool Mahidharia, Narender Sharma, Vaibhav Chhabra — Makers Asylum (India)

The People behind the Project

Maker's Asylum is a playground for artists, designers, engineers, doctors or anyone who wants to get their hands dirty and make their ideas happen. When India progressed into a national lockdown in March, the team began to work remotely on the M-19 Shield.

Distributedly Designed

India faced serious shortages of PPE. Maker's Asylum navigated requests for PPE through social media in which shields were then sent to healthcare professionals, police forces and local governments. The PPE was manufactured in the Maker's Asylum makerspace and from a large converted infrastructure in the industrial hub of Mumbai.

The Hard Facts

The M-19 initiative initially intended to send 1,000 M-19 shields to frontline workers. The project then raised around fifty thousand dollars via a crowdfunding campaign, and within 49 days, they were able to give one million + to 42 cities, towns and villages through the #theM19Collective. The shield can be produced using a laser cutter due to the low numbers of 3D-printers in India. This modular design went through 21 iterations using feedback from medical professionals, and uses locally available materials. The shield is made from OHP/PET sheets, a foam board, and an elastic band.

Sending Bits, not Atoms

This open-source design has now been produced globally, from Australia, Kenya, the US and France, to name a few. Maker's Asylum is now creating a much larger platform with this network that will focus on a decentralised approach to innovation, design and manufacturing in India.

Makers Asylum, India, 2020.

Ondřej Veverka, Tomáš Kroutil — Prusa (Czech Republic)

The People behind the Project

Prusa is a globally-renowned 3D-printer company. Prusa primarily sent their masks to frontline workers, receiving over 150,000 requests, collaborating closely with the Ministry of Health to iterate the designs.

Distributedly Designed

Similar to many places across the world, there was also a large demand for PPE equipment across the Czech Republic. Prusa therefore redesigned their original model to accelerate the printing time of PPE.

The Hard Facts

The collaboration with the Ministry of Health meant that Prusa could medically certify their design. The Prusa PRO version has passed the official certification procedure— it provides not only frontal protection (like the RC3 version) but protection on the sides as well. The Prusa PRO Face Shield meets the standard of EN 166:2001 for protection against drops and sprays (protection class 3). Prusa has sent out 208,000 pieces of PPE. The headband is made from plastic and the visor is made from PETG, which was notably difficult to source. The project was funded by Prusa, with a later request for donations to cover the costs. Prusa used their 600 Prusa MK3 printers in their 3D-Print Farm to manufacture the PPE.

Sending Bits, not Atoms

This design is completely open-source open-source and can be downloaded. This enabled Prusa to make many new connections through digital means. Their connection with hobby circles and communities enabled the printing of 100,000 + pieces globally, which also facilitated the discussions and optimised design of the PPE.

Prusa, Czech Republic, 2020.

Chapter 04

QUALITY ASSURANCE, VALIDATION OF DESIGNS, COPYRIGHTS AND PATENTS

The mass-mobilisation of makers and designers during COVID-19 saw the quick-release of many different iterations of masks and PPE. However, with the release of this equipment comes the question of quality assurance, design validation and the use of copyrights and patents. This chapter contains articles reflecting on the push to certify mask designs, articles on open licensing and intellectual property from a scholarly, business and design agency perspective.

“Quality Assurance, Validation of Designs, Copyrights and Patents” contains contributions from Dymphie Braun, Fátima São Simão, Professor Jorge L. Contreras and Tze Lee.

The Validation of Design

Dymphie Braun from Pakhuis de Zwijger

In times of COVID-19, distributed design had quickly become our reality out of necessity. Fab Labs and maker spaces started distributing machines, companies started collaborating, and designers worldwide opened their processes to rapidly design, and many individuals wanted to help and innovate health and wellbeing equipment in response to the crisis on a global scale. For one, distributed design and digital fabrication can help overcome supply problems in a crisis. For effectively supporting the fight against COVID-19, you need to know, however, where your help really has an impact on medical needs.

Quick Response with Local Production

Paulien Melis, programme developer at Amsterdam-based research institute Waag, works at MakeHealth Lab — a programme where they invite people with healthcare questions, healthcare professionals, makers and designers to co-design and co-develop personalised healthcare solutions. Current markets are only serving a certain amount of people, but some have special needs as the materials don't fit. That's where the capacity of makers and designers comes in. By matching them with people with needs and the know-how to use it, MakeHealth Lab facilitates medical innovation on a local scale.

When COVID-19 hit Europe, MakeHealth Lab focused on the production of medical face shields. According to Paulien, it's critical that medical expertise is involved. "You absolutely need to make sure that it is validated and full proof. Otherwise, you create a fake sense of security and maybe even do more damage by spreading the disease instead of preventing it." While MakeHealth wanted to push co-designed and co-produced solutions on a European and even global scale via networks like www.carebles.org, it was hard gathering insights from health care professionals in these times. "They were all needed for acute care and medical support related to the virus", Paulien adds. "It's amazing to see how fast the maker community responded— bringing their design capabilities, skillset, and power to the table. But designers are no health professionals— validation with research institutes, universities, or healthcare workers is crucial to see if the design is progressing in the best possible way."

'That's also one of the beauties of distributed design; it makes customisation on a large scale possible.'

Finding your Network

Not every maker or designer has a network like that. Where do you find people that can help you validate your design? "There are organisations like TNO (Dutch Organisations for Applied Scientific Research) that can help you, but sometimes it's also the healthcare professionals that reach out because they see a need", Paulien says. "For example, my dentist is producing and developing a mouth mask together with a social lab for sustainist design." There are several ways for collaborating and finding each other, the advice is to take the effort to find that match, and make that search an integral part of your design process.

One of the things Waag did was setting up a shop with laser cutted transparent face shields that can be disinfected. The used files are from a validated design from Belgium-based Makers against Corona, where it's used in hospitals. That's the power of distributed design: instead of producing in Belgium and shipping it to the Netherlands, local production facilities can reach out to local organisations that facilitate elderly care, home care, or other people that need personal safety measures. "Looking at a larger perspective", adds Paulien, "you are also preventing becoming dependent on factories in say China, risking waiting for a shipment that needs to be returned cause it doesn't fit local validations." Distributed design offers short lines and more possibilities in the production and accessibility of equipment.

Pieter van Boheemen, hacker, engineer, and researcher at Rathenau Institute is one of the makers working together with Waag. Pieter started working on PPE based on a snorkeling mask (Snorkel Mask 4 Life, 2020). The mask itself is available at a well known French sporting goods retailer. Adding a 3D-printed connector and a P3 filter, it should protect you from catching the virus. Pieter's sister, who is a doctor working at a hospital and indicated supplies were soon running low, was his motivation to start the project. She showed him a picture of a colleague wearing a similar mask and asked her brother to make her one too. Pieter found online communities with researchers, makers, and designers from Chile, Italy, Croatia, the United States, and many more countries working on designs together. In the Netherlands, he connected with many local makers through a Whatsapp group." Basically, I reached out to everybody that I know that has some connection to personal protection", says Pieter. "That's how I also found someone that could validate what we were actually doing, so he started testing the models in a properly certified setting and the results have been what we were hoping for."

Catering Local Needs

Pieter is using 3D prints for the connectors, which are sufficient for prototypes and single-use. For sterilisable (and therefore reusable) connectors, it is better to produce the connectors by injection molding. The design for the connector is open-source and published on Thingiverse. He published two different files, one for the connection to the mask (from Decathlon) and one for the connection to the filter (RD40). That's also one of the beauties of distributed design; it makes customisation on a large scale possible.

It's also what Erik Cederberg, lead engineer at Stockholm based 3DVerkstan and co-founder of Makers of Sweden figured out. Erik and his team designed a quick to print and easy to assemble protective visor, consisting of a frame for holding standard sized plastic sheets. The plastic shield can be made out of any semi-stiff plastic sheet between 0.1 and 1mm, including overhead film, cover sheets for binding machines, etc, as long as it is available in a suitable format. Soon, architecture firms, design studios and maker labs across the world were using their 3D-printers and laser cutters to make thousands of copies of his clinically tested #3DVFaceshield, which are being delivered to hospitals for distribution to frontline medical staff amid shortages of the safety devices. Due to the difference in standards for hole punchers (the ones you get in an office supply store), Erik's open-source design is available in three versions: for Sweden, Europe, and North-America.

"We felt the need to come up with a design that was effective, fast to print, and can be manufactured in large quantities. We expected it would take a few more weeks before the medical supply industry would be able to start up the process of local production. To meet short term demand, distributed design and manufacturing would be really useful so we started designing quite iteratively with the help of professionals working at one of the larger hospitals in Stockholm." Within 72 hours and many prototypes, they came up with publishable files. Official governmental validation in Sweden costs about eight thousand euros and takes three weeks, so they decided to do an internal validation with five different hospitals instead. After positive results, each local healthcare region independently (Sweden has a decentralised healthcare system where the 21 regions themselves establish principles and guidelines and set the political agenda for health and medical care) decided to take the responsibility for distribution and provided local hospitals with the face shields. By mid-April— as far as Erik can oversee— Swedish volunteers already printed at least 70,000 copies of the design. worldwide numbers are hard to track.

The most impressive story though came from Ghana, where a local surgeon reached out to Erik with the message asking him to send one visor so he could ask a local plastic factory to copy the design. Erik remotely connected him with a local one-man factory he found online who's building 3D-printers for the West African market. Together, they were able to set up a print farm for the hospital. "What made a huge difference is when lots of maker groups and even companies started pivoting towards injection molding with this design. There are at least seven factories that I know of that are doing that now. Two of them are located in India and they can produce 70,000 copies a day that way."

Customised Design

Erik wanted to design something that could be made with locally available materials. "Where can we find transparent plastic in large quantities that people can get easily? Office supply stores! Sheets, overhead film, rapport covers, basically everything that is A4 shaped and transparent enough", says Erik. "The next question is: how do you fasten that on a 3D-printed part? You could use a laser cutter for that but we felt we needed a more common tool." Hole punchers are something that every household, office, or hospital has available. However, because the dimensions of hole punchers differ worldwide (for example, Sweden has a four-hole national standard that is almost exclusively used), multiple designs were needed. "I have definitely learned way more about hole punchers than I knew before", Erik answers with a smile. To test the design for the North-American market, he called in a favour from an American friend for help. "In the US, Canada, and in a part of Mexico and the Philippines, a three-hole standard is widely used. The first test showed three holes are not strong enough to hold the sheet, so we designed a frame with six holders which means you have to punch the sheet twice." In the design, Erik took into account that it is suitable for different head sizes by giving an option to add a rubber band for optimal security.

Pakhuis de Zwijger, Amsterdam, 2020.

Co-creation and Validation

Amsterdam-based FROLIC studio also wanted to put their resources and network towards COVID-19 critical challenges. Rather than adding stuff to what the maker community already was successfully doing— making more personal protective equipment— the team of multidisciplinary designers decided to focus more on recycling as a way to handle the scarcity of equipment based on knowledge gained from conducting in-depth research and interviews with healthcare workers and organisations. Was it technically possible to design something that would work for this particular case? Medical research published by an American University gave them the confidence to push through designing a COVID-19 Decontamination Kit. “Validation in design means many things”, says Ismael Velo Feijoo, product designer at FROLIC. “One thing is testing if the solution is actually adding something. For that, we set up a design research process parallel to the development of the device. We needed to dive into the context, which is a strategy you always want to take.” The team designed the DIY decontamination toolkit based on IKEA’s KUGGIS box, which can be put together for around fifty euros and uses UV-C light to sterilise and extend the life of protective face masks. “When we had the first prototype ready, we found a lab in Germany who was not only capable but also willing to help us. That happened all in the first week of designing.”

Availability of Materials

“The minimum decontamination time is the result of a few parameters”, Ismael explains. “It depends, for example, on the size of the box and the power your lamp offers, so we implemented a simple online calculator where you can fill in these different parameters and it will tell you an estimation of the time you should leave the personal protective equipment inside, which is already several times higher than what would already be sufficient but with these things you want to be extra sure.” For the kit, you could use any available storage box. But just like Erik, Ismael and his team were also questioning which supplier is almost always present . “In our case, we figured that was IKEA”, Ismael answers. “The box is relatively cheap to afford and fits well, it has the perfect shape. Another reason is that we needed it to look better than the average GitHub internet tutorial. It should not only work well, but it should by its look communicate trust as well, that it is something reliable. Technically, it would also work with a cardboard box with tape around it.”

Taking a Deep Dive

Just like Paulien experienced the lack of availability of health care professionals for the design process, also FROLIC had to try extra hard. Due to COVID-19, they couldn’t physically show up to the places where their design might be deployed. Instead, they set up a series of (online) interviews that gave them insights from the practitioners working in the first line of action. “The challenge was to gather all this information and also process it so we would end up with a good picture of all the needs and wants in such a short amount of time.”This was made possible with the help of volunteers who came out to offer their skills after an online call-out, in addition to dozens of medical healthcare workers and people on the frontline who answered their call and shared their stories. “Although it was important to understand the user interaction with the product, this also helped us with the details to make it really powerful, like how you handle the type of advice you give, or the safety considerations, all that wouldn’t be possible without this research. Paradoxically, the COVID-19 decontamination kit is a result of taking a step back, and not responding immediately to what was surfacing online and around us”, Ismael adds.

Pakhuis de Zwijger,
Amsterdam, 2020.

(De)centralised Coordination and Distribution

To maximise the efficiency of these kinds of design projects, the need for large scale coordination may be bigger than ever. “When it comes to healthcare, hospitals and the protection of healthcare workers, it would make perfect sense if governmental organisations were the ones taking the lead”, Pieter says. “But when we talk about everyone else that needs protective gear, it’s more kind of an open-market situation. For some, like terminally ill people or other people with vulnerable health issues, it is super important to stay protected. I would like to see some kind of centralised coordination, but it looks like it is an each-for-their-own kind of situation.” But should it be a governmental health organisation setting requirements for who gets these materials and who doesn’t? “I’m also looking at it from a more global perspective”, Pieter adds. “I’m not only making this for the Dutch market, but also for everyone else on our Earth. For every one that maybe doesn’t have the facilities to validate these kinds of approaches or the capacity to develop this. However, that is what I can do over here, after which I can share it with everyone else”.

'The design capabilities and expertise are the essence and the strength of the maker community, that can happen decentralised. Particular people will step up and find ways of collaborating. However, the production needs to fit the local needs.'

Also Ismael and his team were looking into what their solution could offer in a non-hospital context. “Although we looked at the hospital context to gain knowledge, we are more interested in the contexts where people show up to work every day but to whom the supply of protective equipment is not funneled because the hospitals are a priority. We hope to be particularly useful in elderly care or even supermarkets, where the staff wants to stay protected for a long time but doesn’t have access to all this equipment that is made decentralised and distributed to hospitals and other emergency units”, he explains. Therefore, FROLIC wanted to make it as easy as possible for them to be responsible for their own protective gear. Hence the open-source DIY solution. “We as a studio don’t have the capacity to produce, and there is not a commercial market for our product. What we want to do is optimise the connection between demand and supply and attempt some kind of matchmaking. Fab Labs and maker spaces are great sources, but you need to make a small economic investment to produce. That’s why we think it should be demand-driven, so it could work out as a partnership.”

“You always have to take into account the local situation”, Paulien adds to the answer about responsibility. “The design capabilities and expertise is the essence and the strength of the maker community, that can happen decentralised. Particular people will step up and find ways of collaborating. However, the production needs to fit the local needs.” When it comes to design and the research plus essential and scientific knowledge needed, the maker community has already proved themselves on that part”, Paulien thinks. “Regarding distribution, we should be looking more for exciting distribution channels like the Red Cross and organisations that have direct contact with citizens in need and other healthcare organisations that are not hospitals.”

Distributed Design in a Post-pandemic World

Like Paulien said in the beginning, it’s amazing to see how fast the maker community responded to the COVID-19 crisis. “Translating the specific needs of the medical field into their models, prototypes and final products is the way to go,” she concludes. For future reference, it would be interesting to further investigate the reuse of protective materials and rethink sterilisation and decontamination, instead of continuing the production of disposables. Not only to prevent shortages in case of increasing demand but also because it is more sustainable. Protective gear is needed, but is a polluting game. To open up to these kinds of innovations, healthcare professionals also needed to experience the added value of designers and how processes are researched. Now that the scenery has changed due to COVID-19, we are met with the circumstances of a living lab, an iterative, open-innovation space to explore that real-life. As shown, distributed design opens up new opportunities and different possibilities which will hopefully influence innovative healthcare on a larger and a long-term scale, not just now.

Open Licensing and Business Models

How the Creative Commons Licenses Help Promote a More Sustainable Economic Culture[2]

Fátima São Simão from Science and Technology Park of the University of Porto (UPTEC) and Creative Commons Portugal

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Introduction

Recent international debates about copyright brought to light a series of questions that had not been analysed before. They also made evident the implicit conflict between new more open and sustainable, versus old proprietary economic growth paradigms (Towse, 2010; Handke et al., 2016). Under this context, it is important to consider that many emerging business models, which although not always totally original, have only become possible because of the existence of open licenses such as Creative Commons (Lessig, 2004; Stacey and Pearson, 2017).

In a period when big economic groups, from the most diverse sectors (from entertainment majors to tech giants), continue to pressure and lobby governments to reinforce and extend copyright protection, open licenses such as Creative Commons (creativecommons.org/) became a powerful (possible) alternative to give way for the adoption and development of sustainable business models, allowing the emergence of cutting-edge projects and the opportunity for innovative companies to thrive, particularly in moments of deep crisis, as the new Open Covid Pledge highlights (opencovidpledge.org/). Using the Creative Commons Toolkit for Business and some concrete examples, this article aims to illustrate the main benefits of using open licensing in business models and how their use can contribute to the global copyright debate.

Business Models and Creative Commons

There are many different ways to define what a business model is (Osterwalder & Pigneur, 2010; Saxena et al, 2017). Essentially, one can

say that each business model represents a different way of adding value to a certain good or service and how that value can be developed and delivered. Therefore, for each existing productor service there are multiple possibilities to produce value and generate revenue. Open business models add an important layer to the general definition of business models, as they predict the use of open licensing as a strategic tool, both to enter the market and/ or to maintain the project's growth and sustainability.

When we consider businesses whose products or services are highly dependent on copyright (as is often the case in the creative industries), the use of Creative Commons licenses as a strategic tool can be very effective in promoting projects' sustainability and development. This is not just relevant for young startups or organisations but also for any project that wishes to launch a new product/ service or consolidate its position.

In order to promote the use of Creative Commons licenses in businesses with a view to adopting a more open economic culture,Creative Commons developed a toolkit that provides an easy understanding of the benefits of using the licenses as a strategic element of their business architecture. The toolkit comprises information about the main possible benefits/ effects of the use of Creative Commons licenses or Creative Commons licensed work as well as an Open Business Model Canvas (see below), which is one of the many "spin-offs" of Alex Osterwalder and Pigneur's Business Model Canvas (that, for being licensed under Creative Commons, constitutes in itself a good example of a thriving open business model —we will go back to this again).

Through the observation of the CC Open Business Model Canvas, one can infer that, besides considering the original nine blocks proposed by Osterwalder and Pingeur (2010), three new categories are included:

- The existing Creative Commons licensed works— which can be taken from the countless licensed content available on the web to openly use and reproduce (Creative Commons, 2017).
- The adoption of Creative Commons licenses in new goods or services (as a way to promote the project's product and / or reach the clients).
- Social Good aspect to consider as part of the central value proposition of the project.

Why Using Open Licenses in Business/ Professional Projects?

Within the CC Toolkit for Business projects, we identified six major benefits of the use of CC licenses (or CC licensed work) while designing the firm's business model. Below, we present each one of them in detail.

Reduces Production Costs

By using the available CC licensed works, the project's investment to launch a new product or service can be significantly reduced. CC licensed works (design, photography, film, music...) are made available by a worldwide community of authors, allowing any project to produce effective communication materials without needing to make significant investments. This also applies to product design or development.

Like in any strategy, there is a degree of risk attached: other projects might be using the same CC licensed materials. However, this risk applies to any communication material in general (in different degrees): even when using protected material, one can never be sure of not being copied, regardless of how strong copyright law is.

This also does not eliminate the much higher benefit of hiring qualified professionals to develop customised and exclusive content. And it also suggests the possibility of recruitment through CC content search (which is particularly beneficial to startup projects that do not have a good support network or knowledge about who can provide the products/ services they are looking for). There are companies whose business model is based on this logic: the Noun Project[3], for example, is a communication design company that offers an enormous diversity of icons for free, under Creative Commons licenses. Many designers see in this platform a good opportunity to enter the market, gain visibility, test design proposals or simply monetize old icons they would not otherwise do (Stacey & Pearson, 2017: 91).

Reduces Transaction Costs and Legal Uncertainty

Many companies and professionals who have ever tried to use copyrighted works owned by third parties are aware of how burdensome the rights clearance process can be. Authors and owners sometimes may be difficult to locate; other times they are not interested in engaging in negotiation; the terms and conditions imposed can also make it impossible to get a deal; lastly, when a company does reach an agreement, if it doesn't hire a specialized lawyer to draft the contract, it will probably be at risk of not getting all the rights it needs in order to proceed with the intended use. CC licenses are free standardized copyright licenses with a very high global reach. Currently used by millions of people and businesses, including some of the biggest institutions in the world (Creative Commons, 2017), they became an effective means to help reduce the costs of transactions (intrinsic to international activity) that would otherwise be necessary each time a project wants to use and reuse content that includes third parties' work. By doing so, the licenses also grant a possibility of control over the works' developments that would otherwise be almost completely in the hands of specialized intermediaries.

OpenDesk is an example of how open licenses can not only simplify licensing processes but also promote the internationalisation process of a project. By connecting designers to its customers and local makers around the world through its online platform, OpenDesk has developed an easy and affordable way to set up contemporary office spaces (Stacey & Pearson, 2017: 99).

Increases Access to Innovation

Using CC licenses on produced content and making it available to the project's target audience may turn out to be an effective way of doing market tests before they actually release the final product. By doing so, the project allows their potential clients and partners to actually try the product beforehand and provide feedback. As they become engaged in the entire development process, they also become part of a collaborative open innovation process – a sort of international research, development and innovation team that might not otherwise be possible.

A successful example of this is Arduino, "an open-source electronics platform based on easy-to-use hardware and software" (Stacey & Pearson, 2017: 47). By providing openly licensed products and content, they allow their community of users to actually engage in an open innovation process that can actually result in new products (id. ib.: 48).

It is also the case of Blender, an animation platform that developed its own open-source 3D software and produces CC licensed films. By licensing their work, "each open-movie Blender runs / produces a host of openly licensed outputs, not just the final film itself but all of the source materials as well. The creative process also enhances the development of Blender software because the technical team responds directly to the needs of the film production team" (id. ib.: 55). In the case of Blender, it is interesting to note that the adoption of open licenses also allowed innovation from an economic perspective (and not only technological or creative): as a way to make their business sustainable (after previous failures with private investors), Blender created a subscription model for its community of users (who are also often clients) who, despite all assets being openly licensed, always has access to new products and features beforehand (they also sell physical copies of their films and merchandising).

Increases First Mover Advantage

Intellectual property (IP) in general is known as a barrier to market entry (Samuelson & Nordhaus, [1989] 1999); Towse & Hendke, 2013). This can happen in two ways:

- It prevents the company from openly using goods that are under IP protection and could otherwise be more accessible

(particularly, those that have been publicly funded) and
- It sometimes prevents individuals' or small structures' own creative/ innovative products from entering the market, as it is often too expensive to protect them (and keep them protected) when in conflict with more resourceful structures.

By licensing its own production under CC, the possibilities of entering the market not only accelerate (and, thus, the chances to gain an interesting market / audience share increase – even when it is a small niche, which for most creative projects is crucial) but also the chances to raise awareness and build a following, grow. If the product is indeed innovative this might mean the project will have established a first mover advantage. This means that, while competitors are still trying to catch up, the team will already be in a comfortable position to continue to innovate. This can be particularly useful for creative structures (or individual professionals) as it can apply directly to their value proposition(s), allowing them to design different versions of their solutions.

By making their tool accessible, shareable and "remixable'' (under the use of CC licenses) by anyone interested, Osterwalder and Pigneur's (2010) Business Model Canvas (BMC) soon became the most widespread canvas to help young startups structuring their businesses. This was crucial to make their business rapidly gain and keep an important market share, despite the competition that followed. (Or even the competition that was already in place – but not openly licensed.) The choice to openly license the BMC made it very easy and cheap to share, use and reuse. Under the umbrella of Strategyzer, the BMC continues to serve as the main key for this company to sell its products (books, management software, training videos) and deliver services such as certified workshops (although others can still develop their own formats), online courses or specialised coaching to young teams.

Increases "Opportunity Benefits"

Opportunity costs are a well-known economic concept, created to define the cost of not having taken the benefit of an alternative option to one's decision (Samuelson & Nordhaus, [1989] 1999). When using CC licenses, projects face opportunity costs. But they also increase their chances to enjoy opportunity benefits. This means that, by making a solution available for others to reuse, readapt and share, unexpected returns that would otherwise not have been guessed possible is surprising.

CC licenses open up the possibility of forming a collaborative, distributed production network that can include fellow creators, end users, customers and partners who make improvements to the actual design or functionality of their product. The result can be unexpected: it can be a brand new product, an extended version of the original or even a series of different products (whether or not related to the original).

'When a team marks its product with a CC license, it is also building a reputation: it shows the public that it is broadly interested in collaboration and interaction. The use of CC is not only valuable from the perspective of its proven legal asset as a copyright-based license, it can also be a powerful tool for the construction of a solid network of stakeholders around a project.'

Going back to the Arduino example, not only has it allowed for "dozens of Arduino derivatives out there" (Stacey & Pearson, 2017: 49), it has also benefited from many new "ideas and designs that Arduino and the Arduino community use and incorporate into new products" (id. ib.).

When a team marks its product with a CC license, it is also building a reputation: it shows the public that it is broadly interested in collaboration and interaction. The use of CC is not only valuable from the perspective of its proven legal asset as a copyright-based license, it can also be a powerful tool for the construction of a solid network of stakeholders around a project. This means open licenses are also a sort of communication tool as their use can be shorthand for "we get the Internet, we're on the right side of this debate, and we want our users to know that we see them as partners/collaborators" (Creative Commons, 2015).

Promotes Sustainability

The use of CC licenses or CC licensed work in a product or service can also send a message to the public that the organisation behind it is socially aware and is working towards generating revenue but equally ensuring that everyone can improve and benefit from the developed solution.

By placing the organisation in a network of collaborative users, clients, partners and suppliers, the use of CC licenses allows it to keep a light structure, reducing costs by only using the resources that are essential to guarantee the project's sustainability and work on a network economy model. It also guarantees that others get the chance to develop new business models, create new products and services and generate new jobs and revenue streams after that same original product, thus not having to replicate the entirety of the work that has been developed and therefore preventing waste.

The use of CC licenses (and open licensing in general) in projects (and businesses) can be a way to promote a network of sustainable open, small and medium structures as opposed to a market highly concentrated in the hands of a few closed large corporations that, by creating global monopolies based on a protective attitude, induce artificial scarcity and control global production and access to cultural and creative goods and services (Bilton, 1999; Oakley & O'Brian, 2016; Towse, 2010, 2011).

Conclusion

Despite their different strategies (some more open than others), all the examples mentioned above have somehow benefited from the use of open licenses, often allowing / promoting the emergence of "derivative" projects that used their original open solution. Open licenses can, therefore, be a strategic instrument not only at market entry level but also in promoting projects' sustainability. Of course, as every other instrument, the adoption of open licenses also implies risks. Yet, in terms of general welfare, because they imply a wider access to the benefits produced, these risks seem to be less damaging than the well-known negative impacts of proprietary business models (which often end up repressing overall creativity and innovation).

Besides the companies referred in this paper, other examples could have been mentioned to illustrate our argument both from private sector (The Noun Project, Cards Against Humanity, Wikihouse, Moot, Tribe of Noise, Elemental, Figshare, Monster Jinx) and from public institutions like museums or education structures (Reijksmuseum, National — Portrait Gallery, PLOS— Public Library of Science, Wikimedia Foundation). This suggests that open business models might be more than just an interesting solution at an individual project/ product level: they are also a powerful tool at a more organisational level, as they suggest the possibility of new forms of hybrid structures that combine both public and private goals, with both clear economic and social goals and responsibilities.

However, such models still remain under threat as copyright reforms all over the world continue to repress possibilities of sharing and collaboration. Their efficiency and contribution to economic wealth needs to be highlighted and clarified, in order to balance the dialogue and promote an honest, transparent discussion regarding copyright (and eventually other intellectual property rights) among all interested parties —by exposing how they are actually contributing to the growing concentration of economic power (Handke, 2011; São Simão, 2020).

Instruments such as the Creative Commons licenses (creativecommons.org/) or the more recent Open Covid Licenses (opencovidpledge.org/) were created to offer transitory solutions, in response to the slow adjustment of the law to the fast technology development we've been going through. Yet small and medium organisations and average individual creators and

professionals, who would more promptly benefit from such a reform, often do not seem to be aware or engaged enough in debate and many of them still prefer to adopt a more protective attitude due to the persistent (some say intentional; see Dobusch & Quack, 2012) asymmetry of information (Towse, 2010; Handke et al., 2016). It is interesting to note, though, that the current COVID-19 pandemic seems to be pushing even some of the biggest proprietary structures towards a more open attitude (as is the case of some of the Open Covid Pledge supporters)… Nevertheless, this discussion still seems to ignore the full potential of a more open economic (and cultural) paradigm and the actual needs and interests of the vast majority of creators (and their creative work) who, after all, are the very reason why copyright even exists.

Pledging Intellectual Property for Distributed Design

Professor Jorge L. Contreras from the S.J. Quinney College of Law at the University of Utah

IP and Distributed Design

"Intellectual property" (IP) describes a range of legally-recognized protections for inventions, works of authorship, designs and other intangible items. A typical fabricated product is often covered by multiple types of IP: the electronic design file may be copyrighted and protected as a trade secret, the form of the product itself may be protected by an array of rights including copyright, design patents, trade dress and design registrations, and the functional aspects of a product may be protected by one or more utility patents. If the product itself displays or acts as a company's brand (e.g., Mattel's Barbie®), then trademark rights may also exist.

In order to fabricate (legally) a product that is covered by IP rights, a maker needs permission— called a license— from the owner of those rights. Such a license is usually granted when someone posts a design file online for others to use, but that is not always the case. For example, the person posting the file may not be the author of the file and may not have permission from the author to post it. And even if use of the file is permitted, someone may have rights covering the resulting physical product. If someone uses a design file to fabricate a product without all of the necessary licenses, then that person could be liable to a legal claim by the owner of the relevant IP.

IP and COVID-19

In the race to produce face shields, masks, ventilator parts and other products in response to the COVID-19 pandemic, issues relating to IP and licenses have gained international attention. In March, 2020, two young Italian engineers used a 3D-printer to fabricate more than a hundred ventilator replacement valves for a local hospital. Because the manufacturer had refused to provide them with the design files for the valve, they created their own. Soon thereafter, news stories began to emerge that the ventilator

'In the race to produce face shields, masks, ventilator parts and other products in response to the COVID-19 pandemic, issues relating to IP and licenses have gained international attention. '

manufacturer had threatened the engineers with a lawsuit, possibly over patents covering the design (Peters, 2020). While the company denied these allegations and no suit was actually filed, the episode galvanized many in the maker community, as well as legal experts around the world, to find ways to open IP in the fight against COVID-19.

Response by the Ventilator Community

Some manufacturers unilaterally decided to open their designs to the public in response to the pandemic. In late March, UK-based Smiths Group committed to make the IP for its PARAPAC Plus lightweight ventilator available to other manufacturers at no charge. Shortly thereafter, Medtronic, a large Dublin-based equipment vendor, publicly shared the design specifications for its Puritan Bennett 560 ventilator. These commitments have inspired a variety of "open" ventilator projects, including Stanford University's OP-vent, a simple open-source open-source ventilator (op-vent.stanford.edu) and the UK-based Open Ventilator System Initiative (ovsi.org).

The Open COVID Pledge

Around the same time, a group of academics and legal experts in the US and UK began to develop a framework under which companies and institutions could pledge their IP in a lightweight, consistent and legally-enforceable manner. This effort became the Open COVID Pledge.

The Open COVID Pledge (opencovidpledge.org) reads as follows:

- Immediate action is required to halt the COVID-19 pandemic and treat those it has affected. It is a practical and moral imperative that every tool we have at our disposal be applied to develop and deploy technologies on a massive scale without impediment.
- We therefore pledge to make our intellectual property available free of charge for use in ending the COVID-19 pandemic and minimizing the impact of the disease.
- We will implement this pledge through a license that details the terms and conditions under which our intellectual property is made available.

An organisation can "Make the Pledge" by issuing a public statement to that effect and committing to license its IP (patents and copyrights) to anyone who wishes to use them in response to COVID-19. To do this, the Pledge organisers (known as the Open COVID Coalition, now administered by Creative Commons) provide a set of simple template licenses modeled on open-source software agreements and the Creative Commons suite of licenses for online content. A Pledgor can also write its own license agreement, which the Coalition will review and evaluate for consistency with the Pledge.

The license that a Pledgor grants must be open to anyone, free of charge, and must last through the earlier of the end of the COVID-19 pandemic (as declared by the world Health organisation (WHO)) plus one year, or the 1st of January, 2023, depending on the particular license. After that, the free license disappears, but parties are at liberty to renew or negotiate for a longer term. The important thing, according to the Coalition, is that IP be made freely available for purposes of fighting the COVID-19 pandemic with few or no strings attached.

Uptake and Recognition of the Open COVID Pledge

Since its launch on the 7th of April, 2020, companies and institutions around the world have pledged more than a quarter of a million patents under the Open COVID Pledge. Pledged IP covers medical equipment, protective gear, software algorithms, diagnostic technologies, emergency response systems and much more. Examples of pledged IP can be found on www.opencovidpledge.org. In addition, Swedish firm IPScreener has developed a customized search tool that is accessible from the Open COVID Pledge site to enable text-based searching of pledged patents.

The Open COVID Pledge was recognised by the WHO in its global Solidarity Call to Action to realize equitable global access to COVID-19 health technologies through pooling of knowledge, intellectual property and data (WHO, 2020). The Open COVID Pledge also served as a model for a similar effort in Japan, pursuant to which close to 100 Japanese industrial companies have pledged nearly one million patents to the COVID-19 response (GCKyoto 2020).

The Open COVID Pledge and Distributed Design

The Open COVID Pledge has quickly become an accepted framework for making digital designs broadly and legally available for use in connection with COVID-19. Below are some examples of fabricated devices and designs opened to the public under the Open COVID Pledge:

- The NASA/Jet Propulsion Laboratory has pledged its novel designs for four 3D-printed respirators, including instructions, STL files, and initial test data.
- The New Jersey Institute of Technology has pledged a 3D-printable forceps swab for COVID-19 testing, designed to reduce infection and contamination risk.
- HMJ Medical has pledged its IP relating to Spike Assist – a small disposable device that prevents mis-spiking of IV bags.
- Probuccal Inc. has pledged IP relating to its COVINHOODTM protective device against oral bioaerosols for use with dental patients.
- Sandia National Laboratory evaluated 200,000 design options for face coverings and 900 design options for face shields, considering their effectiveness, durability, build difficulty, cost, and comfort, and has made this data publicly available.

Under each of these pledges, the designs and other information made available by the Pledgor can be used free of charge while the license is in place. Any number of products can be fabricated, replicated, distributed and sold, provided that they are used in response to COVID-19.

Other Legal Considerations

Regulatory Approvals

Despite these broad, enabling permissions, makers should understand that other legal requirements might apply to the fabrication and distribution of products that have medical applications. In many cases, both the design and manufacture of medical devices must be approved by national regulatory authorities such as the Food and Drug Administration (FDA) in the United States. The level of approval depends on a variety of factors including the risks that users of the device might face —a face shield is regulated less heavily than a heart stent. In response to the COVID-19 crisis, the FDA has issued Emergency Use Authorizations (EUAs) that waive labeling and manufacturing requirements for certain products including certain in vitro test kits, infusion pumps, N95 and other respirators, face shields, monitoring devices, ventilators and ventilator accessories (FDA, 2020). These EUAs differ depending on the type of product, and similar waivers may or may not exist in any given country. Thus, makers should check whether the distributor of the design file for such a product offers any advice regarding the regulatory status of the product. If not, it is advisable to ensure independently that the planned devices will be within permitted legal bounds.

IP in Components and Larger Devices

Another factor to consider is that the creators of design files for replacement parts for larger devices (ventilators, pumps, dialysis machines, etc.), even if they pledge all the rights that they do possess, may not control all the necessary IP to make and distribute those parts. For example, a ventilator manufacturer may have a design patent covering the form of a particular valve used in that device. If a designer independently creates a file enabling the fabrication of that valve, the designer likely owns the copyright in that file. However, the designer would not have any rights to the patent covering the design of the valve. To make and distribute the valve, permission would also be required from the owner of the patent —the equipment manufacturer.

And even if a particular part is not patented (in most cases, manufacturers can't patent every one of the thousands of parts in their equipment), a patent may cover the equipment as a whole. If this is the case, then making or installing a replacement part for that equipment could infringe the patent. The law in this area is fuzzy, but involves something called the "right to repair". In the U.S., the owner of a patented piece of equipment generally has the right to repair that equipment so as to restore it to its original operating condition within its expected lifetime, but does not have the right to "reconstruct" the equipment beyond that level (see Contreras, 2020). The law of repair varies from country to country, but makers fabricating parts for patented equipment should be cautious. The best case, of course, is to use a design file provided by the equipment manufacturer itself —like those made available for ventilators by Medtronic and Smiths. But if a manufacturer's design file is not available, be aware that some legal risk exists, especially if the manufacturer views the sale of replacement parts as an important aspect of its business.

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An Open Invitation

The best way to overcome the product-based IP issues identified above is to ensure that as many IP rights as possible are pledged for the production of products and parts necessary to combat COVID-19. To that end:

Designers and IP Owners

Please consider making your IP freely available in the fight against COVID-19 by signing onto the Open COVID Pledge.

Makers

Explore opencovidpledge.org and take advantage of the wealth of IP that has been pledged already.

Everyone

Spread the word and encourage designers and other IP owners to make the Pledge!

Thoughts on Open IP from the Perspective of a Design Innovation Agency

Tze Lee from STUCK Design

Time to Act

It is often not the best design, but the design that is fastest in terms of production (and thereby is able to reach a critical mass of adoption) that has traction. Especially where lives are at stake, speed to get equipment into the hands of users is of the essence. Many design innovation agencies have the tools to create well considered and tested solutions fast, but may not have the means to take it to production and distribution as quickly.

STUCK Design's decision to open up IP, was both an ethical and pragmatic decision. Being part of the Open-Covid pledge, allowed us to contribute innovative solutions as part of a global design community and distribute design solutions quickly through the Creative Commons licence for Covid innovation. Critically, that speed means these solutions stand a higher chance of reaching users faster than we could have on our own.

Opportunity for Impact

The stance to open IP also opens the door to collaboration with no strings attached. In a situation where ownership and profit is not the main driver of innovation, medical agencies were eager to work together, allowing direct access to understand the core needs and challenges of essential care workers. This presented an unprecedented ability to test prototypes and receive immediate feedback. Refining the design through user testing is critical to a good solution. This immediacy is atypical to medical design projects, which would need layers of protocol and approvals to get to that stage of user testing.

Mask Steriliser, Matthew Wong, STUCK Design, Singapore, 2020.

Sustaining Future Impact

STUCK Design's goal for the Open-COVID series of projects, has been to champion local innovation with global impact. We are gratified that the design solutions have been able to spread beyond Singapore. From this open IP experiment, we have experienced some realities on balancing philanthropy and business sustainability that affects how we approach future work and IP. When the pandemic subsides and the Open COVID license reverts to the company, our team will need to address IP which may have potential future value. Managing that well will be the difference between a one-off initiative, and a sustainable business model; one that allows for deliberate and consistent development of meaningful Open IP design.

'It is often not the best design, but the design that is fastest in terms of production (and thereby is able to reach a critical mass of adoption) that has traction.'

STUCK Design

STUCK Design is a multidisciplinary innovation agency that invents products and experiences of the future— for implementation today. By mixing creative technologists, user researchers, designers, and seasoned implementers in the team, STUCK enables businesses to capitalise on the high-potential areas between the artistic and technological disciplines, and human insights. Passionate about balancing pragmatic wit, dedicated craft, and visionary imagination— we create solutions that are surprising, perceptive, and sensible.

Background

Founded in 2009, in a small apartment by five friends, STUCK is currently a mix of 24 designers, university educators, technologists, and multi-disciplinary creatives, and has serviced over 100 clients with more than 400 completed projects. Our projects span across Industrial Design, UI / UX, software development, research and strategy, spatial design, and marketing activations— and win international design awards as well as Singapore's prestigious President's Design Award.

The X-Hood, Matthew Wong, STUCK Design, Singapore, 2020.

Chapter 05

SUPPLY CHAINS AND MATERIALS

How do we design when supply chains pause? The mass shortages of supplies have highlighted our heavy reliance on importing products from China. Yet when these supply chains pause, we have experienced serious consequences. This chapter illustrates how COVID-19 has presented an opportunity to relocalise supply chains to create more distributed, resilient networks using academic analysis of the role of local materials and supply chains, personal experiences of designers who have shifted their business models and an example of innovative hardware design.

“Supply Chains and Materials” contains contributions from Alysia Garmulewicz, Milo Mcloughlin-Greening, Emily Whyman, Vasilis Kostakis and Chris Giotitsas.

The Role of Local Materials in Building Resilience:

A Response to COVID-19

Alysia Garmulewicz from Materiom

Introduction

The COVID-19 pandemic has revealed the vulnerabilities of today's globalised economy, where the breakdown of supply chains has foregrounded their lack of resilience. Resilience, or the ability for a system to bounce back after an unforeseen disturbance, is often operationalized in strict economic terms, where "the system" is the set of industrial producers and consumers. However, it is critical to widen the lens of resilient thinking / resilience-thinking to consider ecological and social system interactions. While sometimes hidden or deemed out of scope, it is becoming increasingly apparent that ecological thresholds are being crossed on a regional and planetary scale with accelerating climate change, land-use change, biodiversity loss, and the altering of biogeochemical cycles through industrial agriculture (Steffen et al. 2015). These impacts of industrial systems threaten the integrity of the biosphere, and with it, the 'safe operating space' for humanity that has persisted during the past 11,700 years of the Holocene (ibid). Given the integrity of the biosphere is the foundation for economic activity, any discussion of economic resilience must take into account ecological and social system dynamics.

This article first introduces the idea of supply chain resilience in the context of the recent pandemic shock. The wider lens of social and ecological resilience is then presented as fundamental to work on supply chain resilience. Ways to integrate social and ecological dynamics in building supply chain resilience are then proposed, with a focus on raw material sourcing and cycling. Not only could such innovations help mitigate future supply chain shocks, they could also help regenerate natural and social capital.

Supply Chain Vulnerability and Response

COVID-19 has revealed the vulnerability of today's supply chains, with the impacts felt mainly in health care, life sciences and food industries (Simchi-Levi and Simchi-Levi 2020; Hobbs 2020). Supply chain vulnerability during the pandemic has been ascribed to their lean and globalised nature (Ivanov and Dolgui 2020), with disruptions coming in the form of demand outpacing supply (in the case of face masks, hand sanitizer and more generally personal protective equipment), and abrupt demand reduction (as in the case of the automotive and airline industries) (ibid). Overall, the pandemic has shone a spotlight on the need for supply chain resilience (Sarkis et al. 2020; Ivanov and Dolgui 2020; Ivanov 2020; Hoek 2020; Hobbs 2020).

The break down in global supply chains brought on by the pandemic has motivated local and regional innovation in production: personal protective equipment, spare parts, and medical devices have been produced by emergent networks of for-profit companies, non-profit enterprises, and digital fabrication communities in many parts of the world (Cutcher-Gershenfeld, Gershenfeld, and Gershenfeld, forthcoming). This has proven a natural experiment in the case for developing local and regional productive capacity. However, many efforts at "bottom up" innovation have encountered regulatory and coordination barriers (Cutcher-Gershenfeld et al., forthcoming). Moreover, simply localizing supply chains is not a panacea, as domestic supply chains can also be overly centralized, vulnerable to the behaviors of a select few (Simchi-Levi and Simchi-Levi 2020). This was evidenced by the recent meat shortages in the United States during the pandemic, where the shutdown of key processing plants caused major impact throughout the whole supply chain (Corkery and Yaffe-Bellany 2020). These challenges underline the importance of considering a more holistic approach that incorporates questions of feedback, scale, adaptive capacity, and governance.

Developing Resilience

Adding local and regional materials supply must be done in a way that adds resilience, defined as the ability to bounce back with the same or similar operational capacity after an unforeseen disturbance. In systems theory it has been shown that businesses of diverse scales help support the long-term maximum system resilience, striking a balance between efficiency due to a small number of large-scale flows, and adaptiveness due to a large and diverse network of small-scale flows (Goerner et al., 2009).

In the business supply chain literature, the term "resilience" is commonly used to mean adding redundancy, through adding extra inventory, maintaining low capacity utilization, and having many suppliers (Michelman 2007). It also means increasing flexibility throughout the supply chain, achieved by using standard processes that can allow interchangeable production systems to be used when a disruption occurs, and maintaining deep relationships with suppliers so as to understand potential disruptions, or a wide variety of supply relationships to enable greater flexibility in times of change (ibid). Departing from the more linear notion of a supply "chain", the concept of supply network has been growing in usage. The concept of a supply network encompasses the idea of emergent innovation, adaptation and change, where the network of actors are understood as a complex-adaptive system (Choi, Dooley, and Rungtusanatham 2001). The idea of supply networks is more attuned with the concept of resilience, which is underpinned by complex-adaptive systems theory. In the rest of this article, the word supply network is used in keeping with this understanding.

In the discussions of supply network resilience, ecological and cultural context are often overlooked. Indeed, socio-ecological resilience, or the understanding of coupled human-environment interactions, underpins the resilience of our productive capacity on a planetary scale (Steffen et al. 2015). Socio-ecological resilience is underpinned by a set of central tenants that are articulated by Biggs, Schlüter, and Schoon (2015): maintaining diversity and redundancy, managing connectivity, managing slow variables and feedbacks, fostering complex-adaptive systems thinking, encouraging learning, broadening participation, and promoting polycentric governance. These are elaborated as follows:

Maintaining diversity and redundancy refers to investment in biodiversity, cultural diversity, economic diversity, and institutional diversity. Such diversity builds critical capacity enabling adaptation to change. Cultural diversity enables new ways of thinking. A range of institutional actors increases the likelihood that novel solutions and innovations are found in a time of change, just as ecosystem stability depends on the ability for ecological communities to contain species that can respond differently to change (McCann 2000). Redundancy also enables adaptation by avoiding the overreliance on single actors or parts of a system: for example, investing in numerous companies and research institutes to develop a vaccine mitigates against the danger of one or many failing. Connectivity, or the nature and strength of interactions between actors, can both negatively and positively affect a system's ability to respond to change: a highly connected community can better pull together in a crisis, while can also enable contagion of a virus. Managing connectivity is thus important to maintaining resilience (Biggs, Schlüter, and Schoon 2015).

Understanding system feedback includes recognizing positive or reinforcing system feedback that accelerates change, as well as dampening, or negative feedback that facilitates the maintenance of the current system state. Fostering complex-adaptive systems thinking means appreciating the complexity of interdependencies that tie our differing economies, societies and ecologies together, and cultivating a mindset that is prepared for disturbances and shocks brought on by their interwoven dynamics. Encouraging learning includes enabling experimentation and continuous updating of ideas and assumptions with the recognition that

one's understanding of complex economic social and ecological systems is at best partial. Broadening participation is about involving a wide range of stakeholders in knowledge co-creation, helping better understand the system dynamics, respond to change, and build trust and legitimacy in decision-making. This involves social justice, economic development, and the inclusion of marginalized voices. Finally, promoting polycentric governance means connecting governance structures at multiple levels of scale and across different cultures with rules and norms that enable collective action and decision making that is appropriate to the challenge at hand. Compared to more centralized forms of governance, polycentric governance allows for local knowledge to be better incorporated into decision-making, and governance solutions to be more customized to the challenge at hand.

Developing Resilient Material Supply Networks

Taken together, these principles are instructive when considering how to build more resilient supply networks that integrate ecological and social systems dynamics. The following looks at how these principles can be operationalized in the context of raw material supply networks by sourcing and cycling materials at multiple scales and developing information and governance systems.

Source and Cycle Materials at Multiple Scales

The concept of a circular economy has emerged in recent years in response to the need to rethink current "linear" economic practices that "take, make, and waste" the Earth's finite materials and undermine natural capital. In a circular economy framework, products, components and materials are maintained and circulated within biological and technical cycles (Ghisellini, Cialani, and Ulgiati 2016; Ellen MacArthur Foundation 2013). Materials that contain valuable nutrients for living organisms circulate in a biological cycle, with most materials being extracted from sources of renewable biomass and re-entering ecological systems through composting and biodegradation. Materials that cannot re-enter ecological systems safely are cycled within the technical cycle, where products, components and materials are shared, repaired, reused, remanufactured, and recycled by industry.

A circular economy benefits overall supply network resilience by providing greater means of monitoring feedback: when waste is designed to be an input to the biosphere or industrial processes, the interdependence of flows through socio-ecological and economic systems is a part of supply network decision making. However, an overreliance on large-scale material flows within a circular economy could undermine system resilience. For instance, if only a few large companies have the capacity to break down technical materials, any unforeseen disruption could cause widespread systemic failure. This is one of the concerns of chemical recycling, where high capital and operational costs, as well as the need for large volumes of feedstock to make the technology economically feasible (Ragaert, Delva, and Van Geem 2017), present barriers for market entry of smaller, more distributed operations. What is needed is material sourcing and cycling at multiple, nested levels of scale, such as national, regional, and local.

Materials sourced from locally abundant sources of biomass offer promise for building system resilience, as biomass is more amenable for local, distributed sourcing and production (Kircher 2018). Appropriate boundaries for sourcing and cycling renewable materials could be the local biome or ecoregion as these are specific to available biomass (World Wildlife Foundation 2020). Quantifying the carrying capacity of local ecosystems to support biomaterial start-ups is important to assessing their potential market scope and scale. A diversity of actors and institutions providing material sourcing and cycling services could also enhance system resilience. Cooperatives, non-governmental organisations, research institutions, centers of local and regional fabrication, as well as traditional corporations could play various roles and be sources of continual learning and adaptation. An example of a more inclusive approach to materials production is the company Biome, who partners with the local communities they are present in to share knowledge and profits associated with the production of their mycelium-based building materials (Biom 2020).

Develop Appropriate Information and Governance Systems

Broadening participation in the sourcing and cycling of materials means participation in the governance of material flows, including ways materials are developed, produced, certified, and disposed of. For example, if materials are to be sourced and cycled by a wider range of institutional actors, there is the need to develop more accessible materials certification pathways, so materials sourced from locally recycled or renewable feedstock can be reliably used within product supply networks. Local to global governing bodies may need to work together in polycentric systems to better regulate the sustainable sourcing of renewable biomass. For example, the French think tank Atelier Luma is partnering with local communities in the Mediterranean region to investigate decentralized production methods for micro and macro-algae species through the use of wetlands as incubators for locally grown biomaterials (Atelier Luma 2020). Broadening participation also means amplifying innovation. Here intellectual property regimes may need rethinking, as in many cases patents and trade secrets applied to material formulations and production processes present a barrier to participation in materials production and cycling. For example, the Materiom platform provides an open database of material formulations made from renewable sources of biomass in an effort to provide open-source materials (Materiom 2020).

Creating appropriate information systems is fundamental for sourcing and cycling materials at multiple scales with broader and more heterogeneous participation. For example, reverse logistics for secondary and waste materials is enabled by Internet-of-Things (IoT) technologies (Sarkis et al. 2020), such as tracking appliances and components, material barcoding and product passports (Kalmykova, Sadagopan, and Rosado 2018). This is aligned with the vision and work of the Fab City initiative, which aims to develop capacity to source and cycle materials within a city, while digital information travels globally. If cities around the world transitioned to the Fab City model (Diez 2018), socio-ecological and economic resilience would be enhanced through the development of local and regional supply networks and supporting data infrastructure for globally interconnected learning and local adaptation.

Conclusion

With the COVID-19 pandemic foregrounding the discussion of supply network resilience, there is a need to amplify the discussion beyond strict economic concerns. The resilience of interwoven socio-ecological and economic systems is of fundamental concern. At this juncture, key aspects of resilience theory can inform the transition to more resilient supply networks. Material supply networks provide a lens to integrate economic, social and ecological systems dynamics. Shifting towards the sourcing and cycling of materials at multiple levels of scale, with broader participation from a range of institutional actors, offers promise for building socio-ecological and economic resilience, and adds to the present focus of materials cycling with a circular economy framework. To enable this shift, innovation is needed in information and governance systems, where data sharing can help facilitate informed decision-making and more adaptive solutions.

COVID-19 as a Catalyst

The Story of the Batch.shield Project—What we have Learnt and Where we are Going

Milo Mcloughlin-Greening from Batch.works

The Coronavirus has brought the fragility of current linear manufacturing models to the world's attention. The global reliance on a centralised manufacturing hub and single supply chain has caused serious issues with the availability of much needed medical equipment. When COVID-19 hit China the rest of the world was left to fend for itself with no access to essential items. New methods of distributed manufacturing have been brought to the forefront as an adaptable and resilient alternative to the traditional model.

Similar to many other initiatives around the globe, the Batch.shield project is an example of people coming together to do what they could with what they had to try to help those around them. Unlike many of the other initiatives, it was almost as though the last few years of hard work and development at the Batch.works headquarters had been leading up to this point.

The company Batch.works was originally founded in 2018 with the sole aim of becoming a leader in the development of a new and distributed manufacturing model. The largest part of this development has been to build a clear knowledge base around creating and optimising unique Design For Manufacture (DFM) techniques, allowing a small bank of customised 3D-printers to be able to pose a realistic alternative to injection moulded plastic parts from overseas.

The Batch.shield project started out as a collaboration between Julien Vaissiers (founder of Batch.works) and designer Milo Mcloughlin-Greening (me). After seeing the amazing actions of the 3D-printing community across the world who were taking the PPE shortage into their own hands, Julien and I met up in the midst of the London lockdown to get to work on our own optimised version of the now iconic 3D-printed face shield. Over a weekend of extremely late nights, we arrived at a design that we were happy with and that we knew we could print en masse using our little farm of ten customised printers located in a shipping container in East London.

Once we had a working design we knew that only a tiny part of the battle had been won. Firstly, we didn't have any money for materials (we were happy to volunteer our time) and secondly, we didn't have any realistic ways of getting our products into the places that really needed them. The last thing that we wanted was to press “go” on production and start making huge quantities of plastic parts that might end up staying in their boxes and being unused.

With the help of London based designer Salome Bezin who had experience working with hospitals, we had begun to make connections to some hospital procurement departments but we still had no concrete agreements or money for the materials we would need. We decided that the best move for us was to embark on a crowdfunding campaign to raise funds and awareness for the project. We took some snazzy photos with a makeshift studio setup (it’s amazing what you can achieve in a shipping container in the middle of the night) and wrote up some text about what we thought we could achieve in terms of production. Then we released our project to the world.

The single most important move that led to the success of our campaign was our slightly cheeky decision to paste the NHS logo on top of our hero image. It pays to be bold sometimes! After sharing the project on social media the donations started to roll in thick and fast and by the following morning we had raised over seven thousand, five hundred pounds (half of the fifteen thousand pounds we were asking for) and our inboxes were full of messages, some angry, some interested. We had been contacted by some extremely high level individuals asking us to remove the NHS logo from our post at once, which we did instantly. However, this not so well-received act had snowballed the project and helped us to land on the desks of a number of hospital procurement teams around the UK.

The next few days were a blur of deal-making and breaking, with us in the middle trying to make sure that we were making the right decisions in order to be able to get PPE to those in need as quickly as possible. There were many internal arguments over whether we should just plough ahead and deliver boxes of shields to the many frontline workers that had privately messaged us, instead of the harder job of finding a way to go through official channels. In the end we partnered with the St.Bartholomew's Hospital Trust who got in contact after seeing our online campaign. They had in fact designed their own version of the visor but did not have a means for producing them. We took a look at what they had come up with and redesigned it applying our unique DFM technique. We were finally happy to have a partner that was extremely local (2KM) that could guarantee the plastic parts we were producing would be distributed to frontline workers across the city. Over the next weeks and with the help of a great team of volunteers, we got to work on manufacturing over 10,000 units with our ten printer farm and delivering them via bicycle courier to the Royal London Hospital.

Batch.shield from Batch.works, London, 2020

The Batch.shield project has taught us a huge amount and helped Batch.works grow immeasurably as a business. Since the completion of our 10,000 unit order with St. Bartholomew's, we have continued with the Batch.shield project commercially as well as taking what we have learnt into new and exciting projects. We have also moved to new premises which we are building into a shared creative community, no more shipping containers! If we really want manufacturing in this new and distributed way to become a realistic alternative to the traditional wasteful model it is really important to lean on the aspects that set it apart from what was there before.

We must be clever economically to prove that making in this localised way can work. With the Batch.shield we focused on the reusable nature of our product to show customers that it is an intelligent choice over time. Current disposable and non-recyclable imported face shields cost around sixty pence. We are proposing a long term reusable headband for two pounds and fifty pence and a less long term but still reusable and recyclable visor for ten pence per unit. Due to the reusable nature of the design, each unit becomes better value for money than an imported product after five uses. This has been an easy sell. We are also now working on a number of other non-PPE projects that are focused on a product service system model. The fact that we are manufacturing in the center of the city and also distributing from there means there are exciting possibilities for us to stay in control of where our material goes after its initial sale and to collect and re-use the material after use, thus creating a closed loop system.

One of the joys of working with 3D-printing in this way is how quickly we could respond to change. An example of this presented itself while working with the St Bartholomew's team. In parallel to working with us on the large 10,000 units order, they pumped a large sum of money into an injection moulded version of their design. On testing the first products out of this more traditional tool, they found that the sliding mechanism that holds the clear visor was not nearly as good as the 3D-printed version Batch.shield had produced. This was due to us being able to quickly iterate using the same tools in the design process that would then be used to manufacture the final parts. This point was further hammered home after the hospital group had invested in having their design CE marked for further sales after the initial surge. They found it impossible to go back to their toolmaker and add the CE marking, whereas we were easily able to amend the laser etched text to add the certification.

Finally and most importantly, we must keep in mind the reason why we are working in this way. Our mission is to be a catalyst for change, using all of the utopian theory about distributed manufacture to make a realistic and working pilot project (in London) to truly shift the way we make things from the extremely wasteful and blind mass production of the centralised model towards something that is more considered, more circular and more sustainable.

No Arduino? No Problem!

How to Design When Supply Chains Pause

Emily Whyman from Fab Lab Barcelona

The Future Learning research group at Fab Lab Barcelona has highlighted the possibilities of distributed design amidst crisis— shifting to local production can create more resilient, sustainable supply chains.

The Barduino was developed as a design response by the Future Learning (FLU). The Barduino is a PCB board which works as a key component of a machine developed to enable students to continue remote working and learning from home. This case is an example of how distributed design can respond to local needs— in this case, for educational purposes. The question remains as to whether newly formed practices such as this will remain in place when supply chains resume.

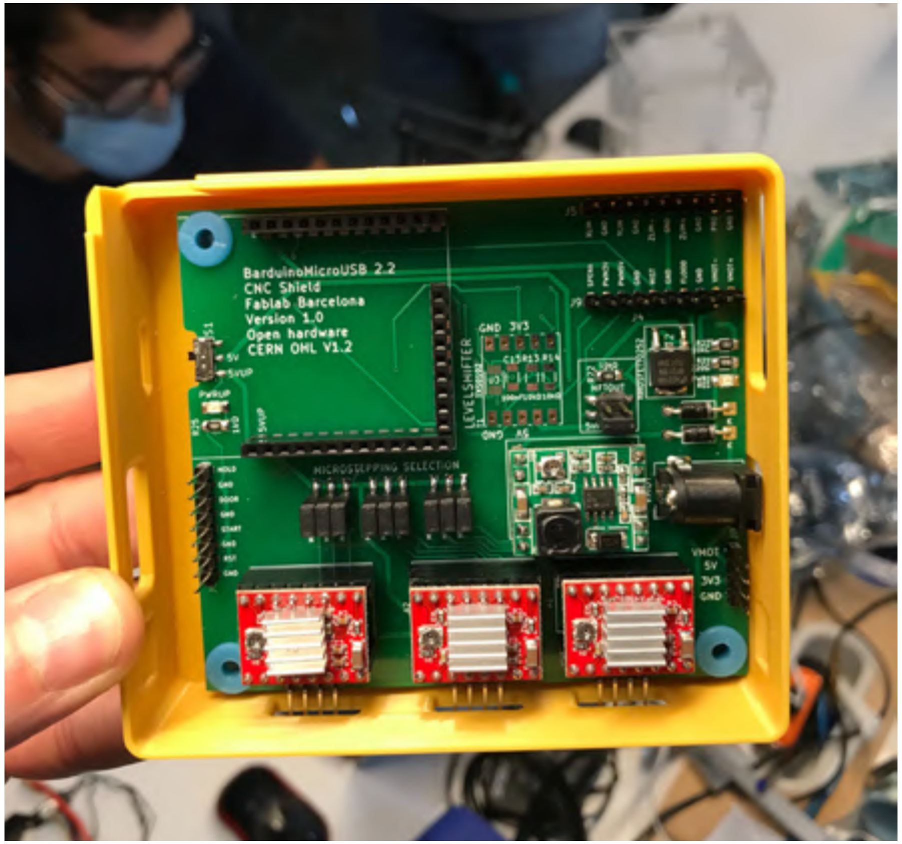
The Shift to Remote Learning

The COVID-19 crisis has made remote learning mandatory for schools, universities, and academies all over the world— including this year's students of Fab Academy Barcelona. Fab Academy is a distributed educational model which teaches students with a hands-on learning experience where students learn rapid-prototyping. These courses are usually connected to a Fab Lab so students can fabricate their designs using the machines, however, the labs have been closed.

Future Learning Unit designed this board so that students could continue to participate in Fab Academy classes. With the emergence of COVID-19, the model was required to become even more distributed, in which students were required to experience 'hands-on learning' from the perimeters of their homes.

(B)arduino Boards

The Barduino started as a project to make an ESP32 Fab Academy compatible board in which students could adapt to their needs for the course. This board was designed by Eduardo Chamorro Martin, with the



The Barduino, Fab Lab Barcelona, 2020.

help of Josep Marti and Oscar Gonzalez from Fab Lab Barcelona's Future Learning research group. It is an adaptation of a previous Arduino Atmega board. The Barduino is an example of how innovation flourishes during periods of necessity. This design is a response to broken supply chains in which the team were unable to purchase PCB boards from China, therefore, they designed and produced their own.

The name Barduino comes from the fact that the machine that it was designed to be used with was the same size as a six-pack of cans (hence, the name "bar"). The "duino" element comes from the board Arduino. Arduino is an open-source and purchasable electronics kit which hosts an expansive community around the world that uses the Arduino to make many different projects, from pocket synth and drum machines to robots. The Barduino is a completely Arduino-compatible microcontroller, therefore, the libraries which work with Arduino, work with the Barduino too. Nice!

The Effect of COVID-19 on Supply Chains

Projects like this have supplied new learning dimensions to the educational space. They provide a hyperconnected learning ecosystem that provides feedback whilst navigating between home, Fab Labs and University. This project reflects how it is possible to learn almost anything in a lab, school or at home, whilst building skills and key competencies to meet social challenges in an uncertain future.

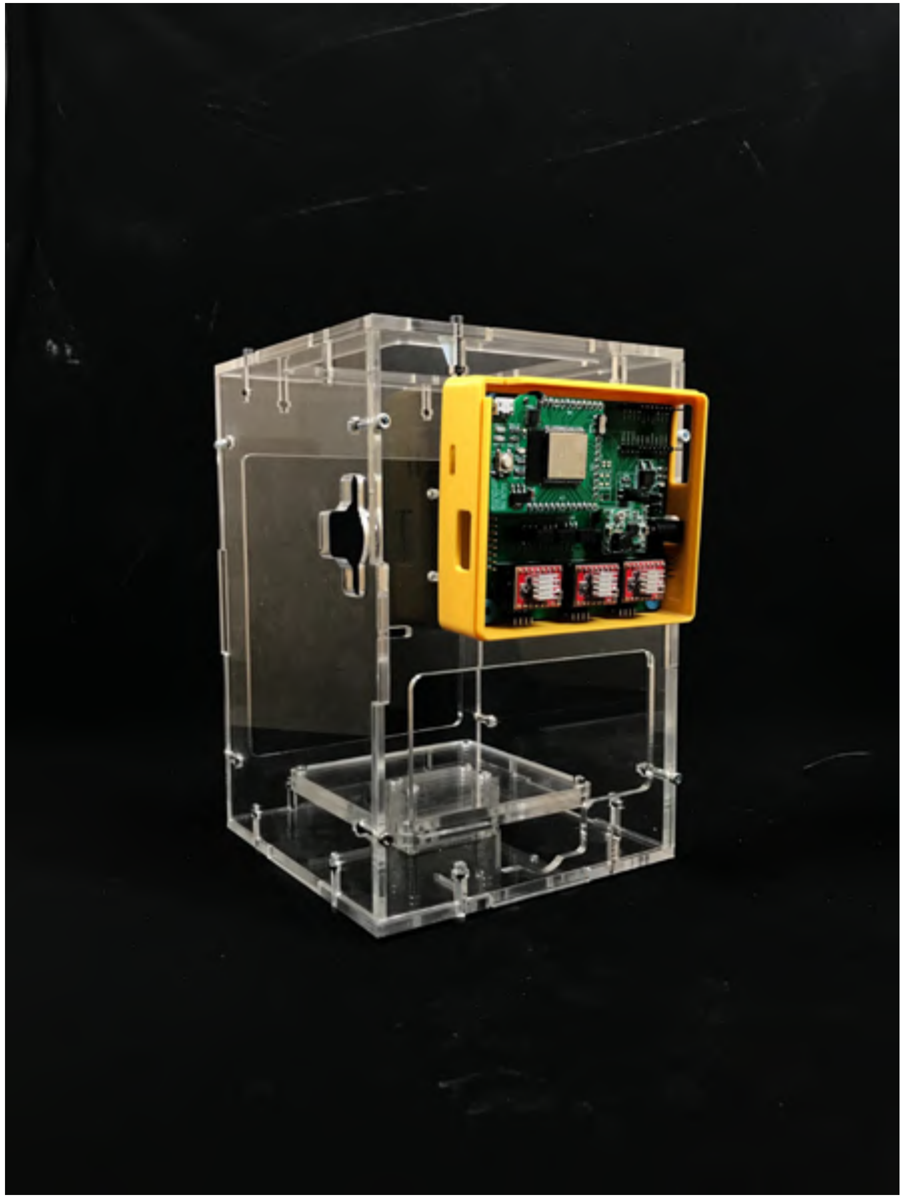
Not only have they created and challenged our learning environments, but they have challenged our wider perspective of how our supply chains could and should work. In the case of Future Learning Unit, it is unlikely that they will shift to purchasing the originally intended microcontrollers again after designing and making a board which they can produce whenever they want (no delivery fees either!). Further, the board has and can be modified. The team later designed a shield which can be mounted on to the Barduino. This exemplifies how when choosing personal production, there is the opportunity to modify, adapt and change the design to the users' desires, without making the previous product obsolete. There is a clause in this however in the extra effort it requires to design and produce the boards rather than simply ordering them. This has to be factored in when considering re-localising manufacturing.

Continuing to Produce Locally

In a post-COVID world, will we maintain the self-productive attitudes we displayed during the lockdown? The Barduino will be continued to be used when supply chains restart, especially due to the learning lesson it provided in its manufacturing, for teacher and student. This case can be applied to other fields. When looking at the effect of COVID-19 on food production, it seems the trends for bread making and baking skyrocketed. Once habits are formed, they can be difficult to break — these positive habits have a domino effect on our competence, but also our reliance on supply chains. If we begin to actively search to produce more locally, then we may transform our current linear methods of production and consumption. Through producing distributedly and locally, we are more likely to know the manufacturer and associate more value to products through experience, contact and conversation. If this is the case, then this is a promising outlook when considering how distributed design could reduce our impact on the environment, whether it be electronics design, food production or other supply chains.

This project was designed from a scarcity of supply, yet it stands as an example of how we can proactively create a resilient future. Choosing to manufacture locally allows personalisation, avoids shipping emissions and minimises the need to bulk buy. It can bolster local economies and livelihoods, and most importantly, prevent future supply chain failure by

providing an abundance of resilient, distributed networks. All we now have to do is to choose innovation from choice, rather than innovation from necessity.



The Barduino, Fab Lab Barcelona, 2020.

Modularity and the Commons as Conditions for a Resilient and Sustainable Society

Vasilis Kostakis and Chris Giotitsas from P2P Lab

Introduction

The COVID-19 pandemic has forced the global society to re-evaluate many facets of "the way we live". It has blatantly exposed the fragility of the globalised economic and production systems. Priorities have shifted and many seem to question what truly matters. Distributed work and design have been elevated to previously unseen levels. However, it has also brought to surface several contradictions and inadequacies of design and production in a distributed way within the incumbent socio-economic system.

This article posits that true modularity is necessary for any type of sustainable distributed design and that we have yet to achieve this as a society. It also highlights commons-based peer production as an emerging mode of production that seems to inherently embrace modularity. Both are ultimately viewed as better suited to tackle the rapidly changing conditions we find ourselves in as well as the challenges predicted for the future.

The Power of Modularity

Modularity describes the degree that independent units are used to construct a more complex system. Think of Lego, or to use an example from nature, think of DNA where different nucleobase modules are joined together. And to draw examples from the digital age, think of the personal computer that consists of the motherboard, the processor memory, the power supply, or see how the parts of an iPhone are produced by several suppliers from all over the world. Modularity is not limited to design; but it encompasses the whole production cycle.

It is in the ICT-driven technological revolution that humanity reached such a level of innovation by building complex products from smaller subsystems, designed independently yet functioning together as a whole (Baldwin and Clark 2000, 2003). Baldwin and Clark (2000) use the computer industry as a case to address the power of modularity because it has the highest degree of modularity compared to other sectors. The degree of modularity describes the degree of coupling between different modules (Persson and Åhlström 2006). Thus, one hundred percent modularity in design means that one function is allocated to one single module while 0% means that all functions are allocated to all different modules (Erens and Verhulst 1997; Ulrich 1995).

The computer includes a perplexing cluster of rapidly changing elements (hardware and software) that function in concert. Modularity enables the handling of this increasingly sophisticated technology. Once a product is broken up into modules, designers, producers, and users gain flexibility while different organisations can work on separate modules knowing that their autonomous efforts will result in a functional artifact (Baldwin and Clark 2000).

Modularity enables different groups to work independently on modules, push deeper into their processes and thus boost the rate of innovation (Baldwin and Clark 2003). The module participants are free to engage in parallel experiments with a wide range of approaches, under the condition that they follow the design rules that allow the modules to fit together (Baldwin and Clark 2003). Therefore, a modular system may offer flexibility and variety in its use and improvement, provided everybody agrees to the overarching rules (Ulrich 2003).

This makes complexity manageable by enabling autonomous experimentation in unforeseen ways (Baldwin and Clark 2003). In addition, commonly mentioned benefits of modularity include cutting down the communication or transaction costs due to distributed problem-solving, enhanced reusability, easier and longer maintenance of the artifact, and advanced customization (Jose and Tollenaere 2005; van Liere et al. 2004; Pekkarinen and Ulkuniemi 2008; Gentile 2013; Garud et al. 2003).

Nevertheless, if technology entails the artifact, the production processes, and the knowledge about the use and the maintenance of the artifact, how can modularity be conceived? Building on Bask et al. (2010) and Baldwin and Clark (2003), four types of modularity can be distinguished:

Modularity in artifact design

it refers to the decomposability of an object into smaller subsystems that may be designed independently but still function together as a whole. For example, see the desktop personal computer that includes the motherboard, the processor memory, the case/chassis, the power supply, the floppy disk etc.

Modularity in production processes

it refers to the way that the artifact is produced. Production includes the whole value chain of an artifact, from its design to its manufacturing and distribution. Modularity in production is often a result of increased modularity in design (Brusoni and Prencipe 2001). Modularity in design is connected to the outsourcing of tasks; however, it is not clear which begets the other (Campagnolo and Camuffo 2010). For example, see how the parts of an iPhone are produced by several suppliers from Japan, China and Korea to Italy and the USA.

Modularity in use

it refers to the possibility that the users may have to mix and match modules so that the artifact suits their needs as well as their ability to maintain them. For example, see the modular shelving systems of IKEA that allow the users to build their bookcases by combining various shelves, using glass or wooden covers, adding lighting or substituting a broken shelf with a new one.

Modularity in services

it refers to a "system of components that offers a well-defined functionality via a precisely described interface and with which a modular service is composed, tailored, customized, and personalized" (Tuunanen et al. 2012, 101). For example, see the Assisted Living Facilities of the Dutch mental healthcare institutions that customizes the residential care people receive to their needs for self-development (Soffers et al. 2014). The healthcare service is decomposed into parts that can be mixed and matched in various ways and thus form a functional whole (Soffers et al. 2014). The modularity in services is an emerging, more complex and context-specific manifestation of modularity (Bask et al. 2010) and may be approached on a case-by-case basis (for a list of diverse case studies of modularity in service see Brax et al. 2017).

Modularity is not limited to design, but it can also or instead encompass processes of the value chain of an artifact. An organisation, an institution or an individual can employ or combine any of these types of modularity. The leading organisations of the digital revolution have arguably gained their competitive advantage, among other reasons, because of the effective integration of modularity into their business models. Modularity allows for-profit firms such as Apple, Samsung, and Amazon to outsource the manufacturing of their products and, in addition to the already stated benefits of modularity, to profit from cheap labor. They may hide the modularity from end-users, and sell the product as a new whole. This enables them to have control over how the modules are integrated into the final product, making it hard to swap modules independently. Further, IBM, Google, and Facebook benefit from crowdsourcing part of their value chain to freelancing or voluntary labor (e.g. the Android ecosystem, the free and open-source software, or the community-based content creation) (Kostakis and Bauwens 2014; Bauwens et al. 2019).

'The COVID-19 outbreak comes as a warning call that we are currently ill-equipped to cope with even an arguably minor "blowback" due to our interventions in the planetary ecosystems.'

The Emergence of Commons-based Peer Production: Opportunities and Challenges

The increasing availability of ICT has made information sharing and grassroots cooperation possible on such a scale that a new mode of production has been emerging: commons-based peer production (Benkler 2006). Commons-based peer production (CBBP) involves Internet-enabled structures that allow people to communicate, self-organise and co-create a commons, i.e. a shared resource, co-governed by its user or productive community according to the rules and norms of that community (Ostrom 1990; Bollier 2014). In CBPP, participants govern the work through participatory practices and create public value that can be used in new iterations (Bauwens et al. 2019).

There is a growing ecosystem of CBPP initiatives. For example, see the free encyclopedia Wikipedia, which has displaced the corporate-organised Encyclopaedia Britannica and the Microsoft Encarta (Silverman 2012; Cohen 2009) or the free and open-source software projects, such as the GNU/Linux that drives the top 500 supercomputers (Top500 2018) or the Apache HTTP Server that is the leading software in the web-server market (Netcraft 2018). While the first wave of CBPP included knowledge and software projects, the second wave seems to be moving towards design, which, when linked to the production of open hardware, can impact manufacturing (Rifkin 2014). For example, see the production of a wide range of artifacts: from low-cost 3D-printers that have shaped a multi-billion-dollar market (Reprap 2018; SmartTech 2016; McCue 2018), to agricultural machines for small-scale farming (Giotitsas 2019), to low-cost prosthetic arms, and to off-grid wind and hydro-electric power generators (Kostakis et al. 2018).

One organisational and production configuration for CBPP has been described as "design global, manufacture local" (Kostakis et al. 2015; 2016; 2018). It reverses the industrial logic of restrictive intellectual properties and global supply chains feeding into economies of scale. Instead, intellectual property is, as a commons, accessible to everyone, with knowledge production taking place openly on a global scale. Manufacturing takes place locally by communities or enterprises, often through shared infrastructures and with regional biophysical conditions-needs under consideration. It embraces the idea of circular economies rejecting the decontextualization of inputs-outputs and related externalities. Therefore, the production seems to be oriented towards sustainability and well-being rather than economic growth. Hence, in addition to the large-scale CBPP initiatives such as Wikipedia and GNU/Linux, small-scale initiatives can also be influential on a larger scale as nodes in a commons-based global network of local networks. Grassroots initiatives, which are organised around shareable informational modules, can have both a local and a global orientation.

'With the climate crisis looming on the horizon, we should always keep in mind that to fully take advantage of distributed design, we need major institutional innovations that require tremendous political support both top-down and bottom-up.'

Modularity is a core characteristic of CBPP (Benkler 2006). For example, on Wikipedia, the content is broken down into smaller components: entries, sections, or paragraphs. People can contribute from one word to thousands of words (or figures). So, the modules allow for any size of the contribution to match different levels of contributors' motivation and time availability – a property called "granularity" (Benkler 2006). Further, it is easy to put the various contributions into the final product. Similar design properties characterise the free and open-source software and the open hardware realm. Modularity enables sharing and human creativity through asynchronous and synchronous collaboration, going beyond the limitations of time and space. To quote Manzini (2013), "the small and the local, when they are open and connected, can, therefore, become a design guideline for creating resilient systems and sustainable qualities, and a positive feedback loop between these systems". In addition to "scaling-up", CBPP initiatives are "scaling-wide".

One key difference of CBPP initiatives from traditional for-profit ones is that the former primarily produce use-value for their communities (von Hippel 2016; Benkler 2006; Bauwens et al. 2019). Their aim is not to maximize profits, but to maximize the sharing and impact of the community-built value. The commons orientation has the potential to address some of the shortcomings of modularity as identified by studies of for-profit implementations.

First, CBPP products are not intentionally designed to become obsolete (Kostakis et al. 2018); of course, one may want to create a product to last as long as possible but eventually fail to do so. The motivation to design for sustainability may address the negative environmental impact of certain modular products due to the planned obsolescence coming from the continual introduction and replacement of modules. To increase profits, some companies may adopt such practices (Agrawal and Ülkü 2013). This depends on the incentives of the producer and the overarching political economy.

Further, another challenge is that a modular product is easy to be copied or imitated by competitors. Some companies may choose to follow an integrated product architecture to keep the relevant knowledge inside the company and avoid imitation (Persson and Åhlström 2006; Seliger and Zettl 2008; Lau 2011). In the for-profit-maximization setting, critical design knowledge and expertise may also be transferred to suppliers (Shamsuzzoha et al. 2008), with whom the outsourcing company may stop cooperating. In CBPP, all knowledge is commodified, thus, such dangers do not exist. Knowledge is not a rival but an anti-rival resource because sharing enhances its value (Bauwens et al. 2019; Benkler 2006; Baldwin and von Hippel 2011). Shared knowledge may enable designers, who are also the users of the product, to have a thorough understanding of the inner working principles of the overall product or process. So, learning may be faster and product development less expensive as a result of permissionless collaborative efforts.

Moreover, Sonego et al. (2018) highlight the need for user-driven design so that the users become more engaged in the maintenance of the product and the producers understand when and how to implement modularity. In CBPP, users are often actively consulted in every step of the technological development process or are the ones developing the artifacts (von Hippel 2016; Giotitsas 2019).

Besides, modularity may hinder optimization (Gershenson et al. 2003; Lau 2011; Pandremenos et al. 2012). By containing redundant physical structure, modular designs may not exploit as much function-sharing as is possible (Ulrich and Seering 1990; Ulrich 1995). For instance, in an automobile, if the alternator and the engine are designed as separate modules, more physical structures (e.g. support bracket, alternator housing) associated with the alternator are needed. In an integrated design, the former would be enclosed in the engine block (Ulrich 1995). In CBPP, shared knowledge and designs create a broader spectrum of options for module functionality and association, while common “protocols” guide their fixation in the integrated structure.

The possibility for localized manufacturing with the freedom to adapt and adjust the knowledge into the local setting (desirable product architecture, culture, environment, needs, materials) may allow for further functional and cultural optimization and customization. Hence, the integrated design optimizes “at the center”, i.e. focusing on the pre-engineered function of the artifact; CBPP delegates optimization processes “at the edges”, following the user perspective rather than engineering requirements. The abovementioned “design global, manufacture local” configuration bears such a dynamic (Kostakis et al. 2015; 2016; 2018; Giotitsas 2019). CBPP, however, is an emerging phenomenon and thus more research is needed to provide robust evidence and a deeper understanding of its dynamics and limitations. Yet its potential cannot be denied.

Opportunities in the Face of Adversity

Modularity is a fundamental aspect of digitalness. It has existed since the creation of ancient human-made artifacts; however, it is in the digital era that the division of human labor is increasingly infused with modularity. Much discussion has been taking place around new technology-focused buzzwords and concepts, arguably without paying enough attention to the organisational potentialities of modularity. CBPP exemplifies one of these potentialities.

CBPP presents dynamics that harness digital technologies by promoting non-coercive cooperation. CBPP questions the basic mainstream economics mantra that humans seek individual profit maximization when engaging in productive activities. It also challenges the conventional organisational structures of property-based, market-regulated organisations.

In a rapidly changing world, society could greatly benefit by such dynamic characteristics. The COVID-19 outbreak comes as a warning call that we are currently ill-equipped to cope with even an arguably minor “blowback” due to our interventions in the planetary ecosystems. Other entries in this book provide creative and inspirational practical responses to the pandemic from communities applying distributed design and collaboration across the globe.

However, with the climate crisis looming on the horizon, we should always keep in mind that to fully take advantage of distributed design, we need major institutional innovations that require tremendous political support both top-down and bottom-up. The CBPP communities are already here. They appear as a qualitative leap that could usher in true modularity in design and inspire us to build inclusive institutions towards a sustainable and resilient world. Let’s make it happen.

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Chapter 06

ORGANISING, DEPLOYMENT AND DISTRIBUTION

COVID-19 had a startling effect on many countries around the world. This chapter illustrates two case studies from Austria and Spain on how makers and Makerspaces began to work collectively, yet distributedly. Makerspaces across the world identified their 3-D printers, laser cutters and technical skills as tools to be able to organise, deploy and distribute medical equipment whilst remaining safe. The personal accounts reflect how new connections and friendships were forged amidst the peak of the crisis, highlighting the effectiveness of collective effort and design responsibility to respond to crises. The chapter also highlights a key non-human element in the fight to mobilise against COVID-19— the digital.

"Organising, Deployment and Distribution" contains contributions from Leyla Jafarmadar and Cesar Garcia Saez.

Happylab: Makers against COVID-19

Starting a Community-driven Distributed Lab throughout Vienna to Produce Face Shields

Leyla Jafarmadar from Happylab Vienna

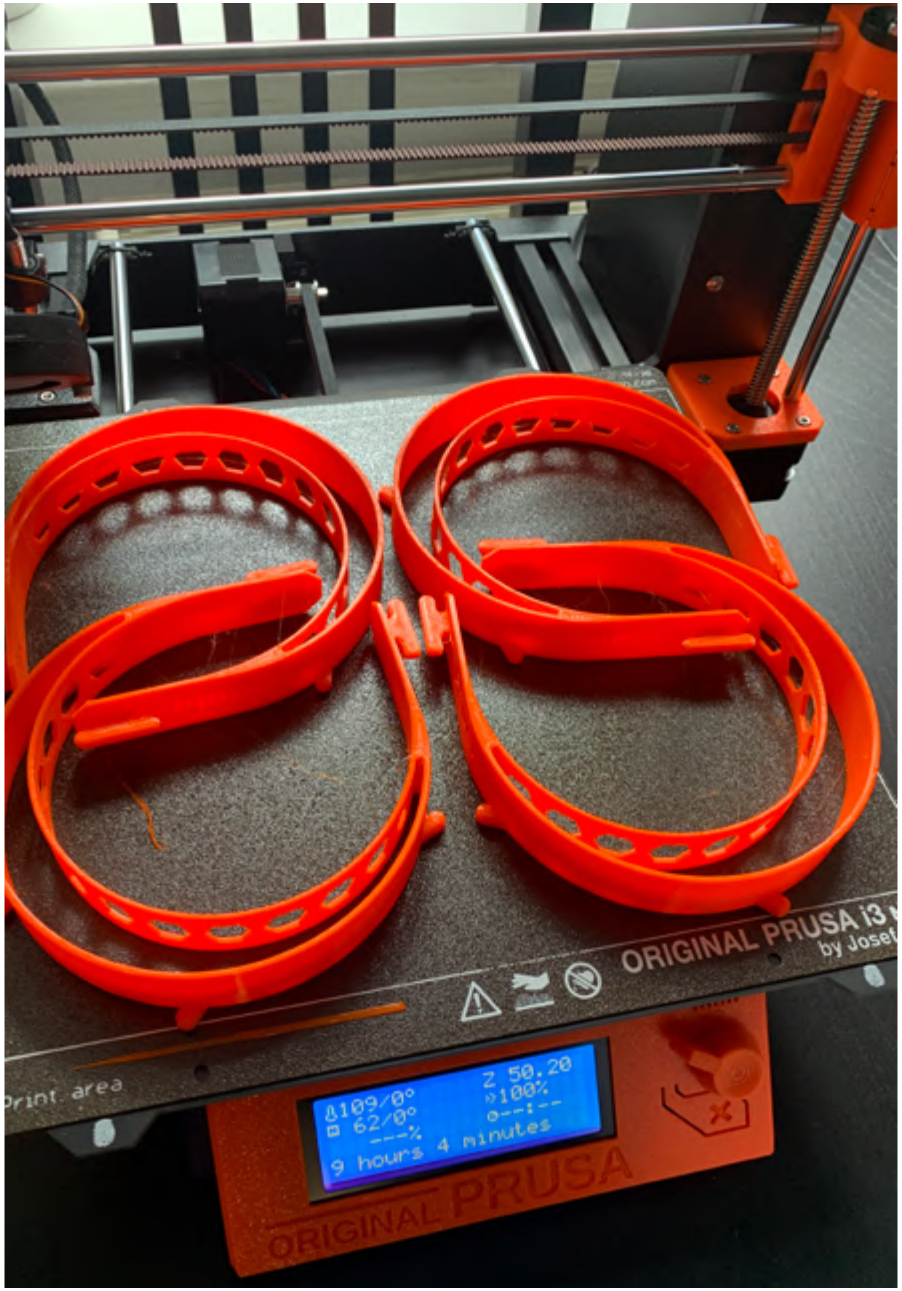
Introduction

When governments all over Europe announced lockdown measures to stop the spread of the Coronavirus, Happylab— like many other makerspaces— had to close its doors to the public from one day to the next in March 2020. Machines that are usually used by our members 24/7 for their own projects were suddenly standing still. Our makerspace that is usually buzzing with makers and their ideas— all of a sudden totally empty.

'The idea was simple: Makers who wanted to volunteer with their private 3D-printers at home could register online.'

While we understood the importance of the lockdown measures, we still wanted to play our part and asked ourselves: how can we, as a maker community, contribute to deal with this global crisis on a local scale? How can we use our resources, machines and knowledge on digital fabrication for the common good?

We were following makers' responses to the shortage of protective equipment for medical professionals, like Josef Prusa's open-source Face Shields, with great interest. But we still needed to find a useful way to get into action ourselves. Where do we start? How do we get in touch with medical professionals in Vienna, Austria? What kind of equipment do they really need? And how big would the overall demand really be?



Printing Prusa's Face Shields with our maker community, Robert Beattie, Vienna, 2020.

Happylab's Shields in action, Vienna, 2020.

First Prototypes of Face Shields for Medical Staff

During the first few days of the lockdown, a member of our makerspace got the ball rolling by connecting us to his friend who was running the emergency hospital temporarily set up in Vienna's trade fair center. They were in need of face shields for their medical personnel and were willing to give the shields created by the maker community a chance.

We produced various prototypes of Face Shields at Happylab— some containing 3D-printed parts, some only laser-cut parts— and handed them over to be evaluated and tested by the medical experts. They chose the open-source design developed by Josef Prusa and his team in Prague and ordered 200 shields that had to be delivered in only a few days.

With this specific goal and tight deadline ahead, it was time to join forces and get our maker community on board. Since Happylab opened its doors as one of Europe's first makerspaces in 2006, we were able to build a community of over 2,000 makers from various backgrounds. We knew that many of them had their own 3D-printers at home and would be willing to help us print the needed headbands. Our idea to turn this project into a community project became clearer: This was going to be a team effort.

'How can we, as a maker community, contribute to deal with this global crisis on a local scale?'

Joining Forces: Austrian COVID-19 Crowd Printing Pool

On Friday the 27th of March, 2020 we launched our Open Call for our newly founded "Austrian COVID-19 Crowd Printing Pool" in our newsletter and on our Social Media channels. The idea was simple: Makers who wanted to volunteer with their private 3D-printers at home could register online, telling us how many 3D-printers they could put in use and how often they could start a print job per day.

The response was overwhelming: In only a few hours 100 makers registered as volunteers and after various nationwide newspapers and radio stations published features about our project, the number quickly rose to over 800 volunteers. On the evening of the same day we provided the first twenty of them with the necessary print files and filament so that they could start printing over the weekend. This marked the birth of our Distributed Lab throughout Vienna that we would be running over the following weeks. We were able to deliver the first 200 Face Shields to the emergency hospital after the first weekend.

Producing over Two Thousand Face Shields with the Help of our Community

As our project reached a wider audience through media coverage, more and more doctors, nurses, staff of nursing homes, pharmacists and shop owners contacted us with their need of protective Face Shields as well. More and more volunteers got involved and together we kept printing headbands. Once finished, our volunteers sent the 3D-printed parts to our headquarters at Happylab where we added the transparent shield and rubber band and took care of delivery. In the end, we produced over 2,000 Face Shields together with our maker community in our Distributed Lab with 3D-printers all over the city. Within one month we were able to cover the urgent demand that was brought to our attention. The support and enthusiasm within our community was inspiring.

'In the end, we produced over 2,000 Face Shields together with our maker community with 3D-printers all over the city.'

The Happylab community produced over 2,000 3D-printed Face Shields for doctors, pharmacies & nurses. Happylab Vienna, 2020.

Tackling New Issues: 3D-printed Face Masks

By the beginning of May 2020, our project led us into a different direction: We decided to pause the production of Face Shields in our Distributed Lab, as more and more suppliers offered shields that could easily meet the demands. Also the process of injection moulding made it possible for bigger companies to produce the headbands in a more time efficient manner.

Instead, we wanted to put our effort into tackling another issue in the field of protective equipment where digital fabrication methods could have a bigger impact in this current situation. In collaboration with the Austrian Health Association, we started to develop 3D-printed professional face masks which are still a scarce commodity in hospitals worldwide. Our prototypes are currently undergoing the process of certification, but once production can start, we're looking forward to mobilising our community and making our Distributed Lab come alive again. "The Austrian COVID-19 Crowd Printing Pool", our database of over 800 volunteers, allows us to react quickly and produce a large number of medical equipment in a short period of time.

The experience of running a Distributed Lab with dedicated volunteers and delivering results within only a few days showed us the real power of maker communities. Our long-term vision, however, is to not only activate makers and their private machines at home, but to also set up locations of our Distributed Lab directly in hospitals to enable the distributed production of medical equipment onsite; it would be the next logical step in connecting the maker movement with the healthcare system, thus pushing the distribution strategy of producing protective medical equipment even further.

Spanish Makers' Ongoing Fight Against COVID-19

Cesar Garcia Saez from Makespace Madrid.
This article was originally commissioned by Makery.info with the support of the Daniel and Nina Carasso Foundation

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Spain was one of the first European countries to be hit by the SARS-CoV-2 virus, right after Italy. The Spanish government declared a State of Emergency and mandated a nationwide lockdown (El País, 2020). During the three months that followed, both ad hoc and existing teams of Spanish makers were communicating, organizing and working remotely to respond to the crisis.

Before the Lockdown

During the weeks leading up to the State of Emergency in Spain, news from Italy and China highlighted the urgent need for lung ventilators to treat patients in Intensive Care Units. Without any corrective measures, the exponential nature of contagion threatened to provoke a peak demand for these devices, and many more potential deaths.

Realising the critical nature of this problem, several groups around the world started working on open-source solutions. In response to Colin Keogh's call to develop an open-source Ventilator on Twitter on the 11th of March, a dedicated group was created on Telegram, parallel to the existing Facebook group, specifically to unite Spanish makers who preferred to collaborate through the popular messaging app.

At the same time, Jorge Barrero, director of COTEC Foundation for Innovation, called on several members of its network (including the author of this article) to evaluate the feasibility of a low-cost 3D-printed ventilator. After receiving positive feedback from several sources, in addition to news about a "small" group of makers tackling the problem, another initiative was born: A.I.RE (Ayuda Innovadora a la Respiración / Innovative Help for Breathing), a WhatsApp group to connect anyone able and willing to help, including doctors, enterprises, makers, innovators, etc. As for the "small" maker group— Coronavirus Makers (@coronavirus_makers)— it spread like wildfire among the Spanish maker community. In the weekend before lockdown, the Telegram group grew to 1,000 members in less than 48 hours. Just two weeks later, it expanded to 16,500 members! But how does a community with thousands of members organise?

Emerging Patterns in Uncertain Times

Once the group started to grow, the number of daily messages exploded. This made it increasingly hard to communicate efficiently, as some topics would be covered repeatedly, for an endless number of times. It was really difficult to know exactly what was needed at any given moment. But soon, several focused workgroups spun off to create their own channels, inviting those interested in their specific topic to hop on board.

Many doctors and enthusiasts were also invited to join the conversation on Telegram, but the groups could be quite noisy and confusing for people who were new to the platform. David Cuartielles, co-founder of Arduino, created a specific forum (Foro A.I.RE) for a slower-paced conversation, distilling the most relevant facts about the topic. Foro A.I.RE attracted some 4,000 individuals within the first month, sharing papers, news and even reference designs for ventilators.

On Telegram, the number of topics was expanding organically, although ventilators still topped the list. Reesistencia Team announced they would start working on an open-source ventilator based on a Jackson Rees type of valve (hence the name "Rees-istencia"). On the 16th of March, they shared the initial design of Reespirator 23, which included a large 3D-printed piece to press the valve. They launched an open call for makers to start the lengthy process of printing these pieces.

This call sparked new regional channels on Coronavirus Makers, working to produce the pieces locally. As most components of the original design were open-source and based on widely available Arduino boards, the initial idea was to produce the ventilators in a distributed way, near to the hospitals in need.

Another priority topic on the channels was PPE, as the urgent need for PPE soon emerged as one of Spain's biggest challenges. As the spread of COVID-19 reached new peaks, news was being reported that Spain was the country with the most infections among healthcare workers (Güell, O. 2020). Makers immediately started working on all kinds of protective gear — goggles, masks and the ever-popular face shield designs.

On the 16th of March, a publication in the forum provided scientific evidence on the usage of face shields to extend the lifespan of masks and prevent large virus-infected droplets from reaching cloth protection and the eyes of medical personnel (Foro CoronavirusMakers, 2020). In Oviedo, Reesistencia Team had finished the prototype and was waiting for a lung simulator to start testing. Makers were eager to help 3D-print pieces, whether for the ventilator or any other project.

Several makers started creating and sharing face shield designs in the Telegram groups (Thingiverse, 2020). These shields were printed by makers all around Spain and given to neighbours who worked in hospitals. This act of kindness allowed for extremely rapid feedback loops. Nurses and doctors would use them during the day and then offer insights about how to improve them and make them more comfortable.

By the end of the week, every region in Spain had large numbers of makers producing face shields and delivering them to hospitals. Given the high volume of this makeshift equipment being used in hospitals, some people started asking questions about the quality of materials used, standards, safety, etc.

Now under new scrutiny, local groups are seeking validation from their respective authorities. Some regions, like Canarias, have authorised the face shields, following standard work safety procedures, until other certified pieces are available. Madrid initially authorised the use of 3D-printed face shields on the 24th of March, but then inexplicably reversed its decision on the 28th of March (Peinado, F. 2020). This movement sparked a huge controversy, as no alternative pieces were available for medical personnel. How could local authorities possibly prefer that doctors and nurses continue working unprotected rather than authorise 3D-printed parts, if only temporarily?

Fortunately, in other regions such as Navarra, the local government contacted the maker group directly and even offered to help with supply and distribution. Valencia followed suit, authorizing a specific 3D-printed model. All this time, the Coronavirus Makers group responded organically, adapting to evolving conditions to continue supporting medical personnel and other collectives in need. For example, on the 30th of March, the Spanish government halted all activity by non-essential workers, to prevent additional movement during the Easter holiday. This put additional stress on providers of raw materials and alternative transportation. One week, face shields would be delivered by volunteers, the next week, it could be by taxi drivers, and during the most extreme lockdown, even police and military members participated in the distribution network!

By the end of the first wave, on the 10th of June, about one million face shields had been produced and distributed in Spain by volunteer makers across the country. A final design has been approved on a national level, both for 3D-printing and injection molding (www.coronavirusmakers.org), so that everyone can produce an open-source 3D-printed face shield that is certified in all regions.

Fab Labs, Makerspaces and Other Pre-existing Collectives

What is the relation between the ad hoc Coronavirus Makers network and other maker groups and spaces that existed before the pandemic? Although the response is quite diverse, with different responses in each region, most Fab Labs, makerspaces and other institutions have been extremely active in fighting the pandemic and contributing supplies for local needs.

Fab Lab Cuenca and Fab Lab Mallorca participated as local coordinators for the Coronavirus Makers groups in their regions, supporting other makers and helping with logistics and equipment. Fab Lab Bilbao and Fab Lab Leon produced new designs for face shields using laser cutters, complementing the production of local maker groups with thousands more units. Fab Lab Xtrene (Almendralejo), Tinkerers Fab Lab (Castelldefels) and Fab Lab Sevilla responded to needs through their pre-existing networks. Maker collectives such as Sevilla Maker Society produced PPE as well, involving unusual partners such as the Betis Football Club to help with distribution. Makespace Madrid has been working on an open-source ventilator, while providing PPE to its neighbours.

In some particular cases, Fab Labs within larger institutions such as universities have not been able to use the spaces, because of local regulations and mandatory stay-at-home orders. Their members have generally contributed their time and personal networks to support the local coronavirus groups. Communication among all these spaces was possible from the start thanks to pre-existing communication channels. Through the shared WhatsApp group for CREFAB, the Spanish Network of Digital Creation and Fabrication (Spaces) shared news, organised local needs, best practices, etc. Other digital fabrication organisations such as Ayudame 3D and FabDeFab stopped their regular activities to help produce PPE, working with their partners and volunteers, supporting the larger cause, while retaining their own identity/brand.

After Three Months of Lockdown

Evolving to adapt to current needs during the past three months, Coronavirus Makers has gone on to produce many other types of PPE. One of the most popular is the “salvaorejas” (ear-savers), a flat piece that secures the straps behind the head instead of around the ears when a mask is worn for an extended period of time. Coronavirus Makers also now has a large group dedicated to textiles, working ethically with workshops and small shops to produce PPE and creating open-source designs for DIY masks called +K rilla and +K Origami (www.coronavirusmakers.org). A distributed group is producing ICU grade masks using injection molded silicone. Other groups have created software such as mobile applications to manage the logistics of deliveries or to encourage healthy habits, such as Higiene COVID-19 (ibid), promoted by the Ecuadorian government.

Spain ended its State of Emergency on the 21st of June. Since the end of May, demand for PPE has dropped, and most people are either going back to their regular work and/or helping other people in their neighborhoods or in other countries. More than 15 coronavirus maker groups in other countries, mostly Spanish-speaking ones, are currently trying to replicate some of these processes to fight COVID-19 in Latin America.

So What Happened to the Open-source Ventilators?

While Spain saw a groundbreaking number of projects to build open-source and low-cost alternatives to help critically ill people breathe, the main challenge with so many ventilators was that the approval steps, requirements, etc., were not clearly defined. Some countries, like the UK, published a document with clear requirements, while the U.S. published special guidelines with less stringent FDA requirements for approval. In Spain, however, there were no such special provisions, so each team working on a ventilator was pretty much on their own.

By the end of March, A.I.RE, through COTEC Foundation, managed to organise an open call with the people in charge of the certification process at the Spanish Agency of Medicine and Health Products (AEMPS). During that call, 115 people representing more than 35 projects could ask questions about the certification process. This information was then published to officially guide the development process (AEMPS, 2020).

To get a prototype approved for clinical trial, it was required to pass tests with a lung simulator, animal trials experiencing severe respiratory distress and electromagnetic compliance. Once reviewed, it would need a final seal of approval from the ethical committee at the hospital. Then it could be used, if and only if, there was no other certified ventilator available for the patient. Under these rules, seven prototypes managed to pass all the tests within the following two weeks. Several of these teams included members from large companies and/or research centers, with expertise in certifying clinical equipment. Others, however, coming from maker/designer backgrounds, managed to have their product approved and even manufactured by large companies, offering maker-friendly versions such as OxyGEN (www.oxygen.protofy.xyz).

While creating a ventilator from scratch is a herculean task, a critical mass of individuals joined the race against the clock. In less than one month, Spain went from zero available ventilators to several ready-to-use devices. By the time this process was over, the impact of lockdown had reduced the number of patients in intensive care. The only two companies producing certified ventilators increased their production tenfold in the past month, with support from the Ministry of Industry, so there was much less need for DIY/maker respirators. Reesistencia Team passed trials of their device with animals, but so far no AEMPS-approved version has been publicly released.

In the tradition of open-source , some of the projects have forked or merged. For example, on the 24th of April Reespirator 2020 was announced as a fork of Reesistencia Team's Reespirator 23 (www.gitlab.com/reespirator/reespirator2020). In this repository, they explained that, even though none of these ventilators would be mass manufactured in Spain, they plan to keep developing them to benefit other countries in need.

Other Spanish Initiatives

During these last three months, makers in Spain have connected with countless companies, institutions and individuals sharing the same goals. Ayuda Digital COVID (formerly known as TIC para Bien), contributed their IT expertise to help create elements of the digital infrastructure. Frena La Curva (Slow down the curve), focused on social aspects, connecting offers and demands from underserved communities (www.frenalacurva.net). European Cluster Alliance (www.clustersalliance.eu/es/) connected Spanish initiatives to a larger pan-European network, promoting cross pollination of ideas among European peers. COVIDWarriors (www.covidwarriors.org) facilitated networking with common goals and provided several hospitals with open-source robots for clinical trials. Sharing a common goal enabled collaboration on multiple scales, at speeds that were unthinkable a few months ago!

Final Gratitude

All the work done by the Spanish maker initiatives would have not been possible without the support of hundreds of companies and individuals that have supplied raw materials, transportation and other elements to channel this maker solidarity. Special gratitude to all our medical personnel: doctors, nurses and everyone involved in mitigating the severe impact of the COVID-19 pandemic!

Chapter 07

LIFE AND TIMES OF COVID-19

This chapter reflects on the experiences of teachers, educators, students and theorists during the COVID-19 pandemic. You can find accounts of projects (Hyper Domestic x Hyper Global) which connect current design practices to the “special period” during Cuba in the 90’s and Fabschools projects. There is also a personal reflection on the shift of teaching in the lockdown, from expectations, adaptations to failures, all of which are punctuated by students' projects which are motivated, inspiring and humane. This chapter highlights how education has shifted during the pandemic, and how peer-to-peer (P2P) networks, the digital commons, and cosmolocalism have facilitated the shift.

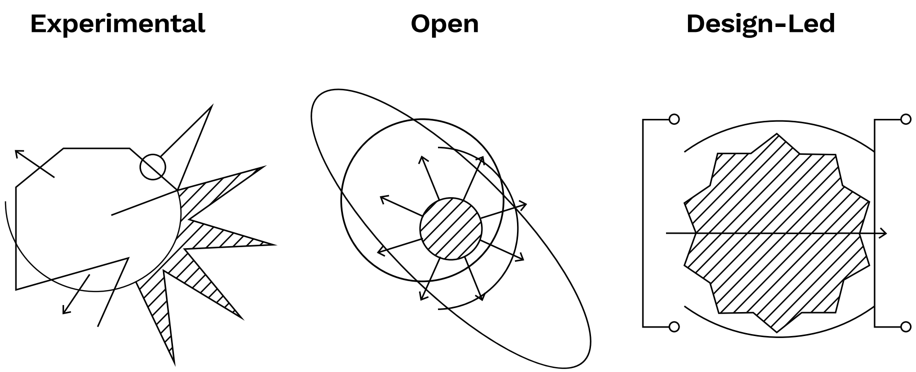
“Life and Times of COVID-19” contains contributions from Nhu Tram Veronica Tran, Julia Danae Bertolaso, André Rocha, Tiago Almeida, Nat Hunter, Gareth Owen, Lucas Lemos and Mads Ohland-Andersen.

Hyper Domestic X Hyper Global

Nhu Tram Veronica Tran and Julia Danae Bertolaso from LINK Journal

Introduction

The emergent reality of the COVID crisis has led to a new form of distributed education, with students now undertaking education from their home countries dotted across the world. This is being implemented by the Master in Design for Emergent Futures students in a collaborative project by Fab Lab Barcelona at the Institute for Advanced Architecture and LINK Journal. The students have been guided and inspired by Cuban activist and artist Ernesto Oroza, whose Technological Disobedience project has made public two iconic books released in the ’90s in Cuba – Con Nuestros Propios Esfuerzos and El Libro de Familia. There are some similarities to the situation in Cuba to the situation we, as a global population, are in now. We are undergoing a fundamental shift in how we value society, how we care for each other and our mobility in the world. The result of the MDEF Hyper Domestic x Hyper Global project is an openly accessible living archive of responses, tools and guides for a post-Corona society, organised in the thematic chapters of Con Nuestros Propios Esfuerzos.



Hyper Domestic x Hyper Global, LINK Journal, 2020

Pandemic and Beliefs

The role of design needs to be further explored, and its meaning deconstructed in order to define near and unprecedented futures. In the project development process of LINK Journal, research was conducted for new methodologies that could be applied in design practice, in order to help us better understand and respond to the fundamental necessities that our society is facing today. A multidisciplinary process is something discussed heavily in both LINK and the Master in Design Emergent Futures, the idea of designers becoming more multifaceted practitioners.

Cuba

LINK has been collaborating with MDEF students on the Hyper Domestic x Hyper Global during the pandemic. This project took example from Con Nuestro Propios Esfuerzos, a publication made in Cuba during the 1990's, when the country was going through a unique period in time after the fall of the Iron Curtain. Ernesto Oroza has been the facilitator of this project in the past, and has been making the work of translating this collection of practices, methodologies and recipes from this book of interest.

The objective of this one week project was to create and find ways of communicating a new iteration of this publication, with content that has emerged from COVID-19 crisis — within education, food, future jobs, and energy. The current global pandemic was observed as an opportunity to initiate this project, finding hyperlocal projects and emergent practices that respond to the current necessity. The students worked to document and collect information, with the aim to create a living archive of the practices collected both in Barcelona and internationally, in response to a global state of emergency. LINK assisted by framing the research, coordinating the project by guiding the students, iterating the process of documentation, and curation of information.

Projects

During this phase, the goal was to create and map the information architecture that can be applied to a more communicative medium, sharing knowledge to the public in a way that is more visually accessible. Projects were very varied — sourdough, masks, balconies, AR, the students also explored more personal approaches from various points of view — product, interaction, societal, and many more.

Distributed Design through HDxHG

Cuba in the 90s was found in a special period —one of scarcity yet abundant in local resources, which triggered an array of socio-technological developments. What we can experience today with the current global pandemic, is finding ourselves in a relatable situation to the one of Cuba in the 90s, where there is isolation in a hyperconnected world that has come to the forefront of daily life. Society today has created an illusion of abundance coupled with a strong resistance to change, which we have come to confront in this crisis. What can be learnt from this situation is that we are not in control of the many factors of our environment, and for this reason we need to find a tool for collective thinking in order to help us map the steps to this new reality.

One of Ernesto's contributions to the project has been the concept of factography, defined as the idea of only collecting and assembling information, creating a big map of content. Hyper Domestic x Hyper Global reformulates this process of factography in a way to visualise and organise debates around the true necessity of society within this current context. Working from different corners of the world, combined with factographic approaches to research and design, the project demonstrates several examples of distributed design methodology today.

'What can be learnt from this situation is that we are not in control of the many factors of our environment, and for this reason we need to find a tool for collective thinking in order to help us map the steps to this new reality.'

Design Practice

As alumni of the MDEF program, LINK is a project that emerged following Veronica and Julia's common experience in the Master in Design for Emergent Futures. LINK is the collective practice of the duo, with the titular project being the titular publication, LINK Journal. Explorations in speculative design as a way to approach some problems in our way of living today which we felt were too complex for us to tackle via creating solutions, so a focus on process and narrative building were key factors. Instead of coming up with an answer, LINK is using design as a means of research and mode of communication.

Various study areas ranged from semiotics (study of sign process, meaning) and biosemiotics (building a bridge between biology, philosophy, linguistics and communication studies), embodied cognition (the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses. Gregory Bateson), and ecological anthropology (study human beings' connection to the environment. Tim Ingold). The process of validating research and iterating comes through the conversations and writings we discuss with people — key contributors, audiences, and editors — the "end users" of the project, are people that are in direct contact within the process of this book.

Key Insights

Key notions underpinning today's fundamental needs have emerged from this project:

Resilience and Adaptation

In order to seed the narratives of resilience through observing emergent actions, designers must act as ethnographers and research; combining both third person perspectives and first person actions to validate research rapidly.

Resistance to change

Society must challenge its resistance to change, and learn to adapt to unpredictable factors in order to redefine the process of transition.

Experience During Crisis

This unforeseen crisis has brought the design practice, along with many other practices, to radically change our way of thinking about the world we have created for ourselves and the one we live in today. From the spread of COVID-19 emerged a common reality that we need, now more than ever, to start working with one another, and use this collective intelligence to answer the complex needs of society in the twenty-first century, on a local and global scale. In the case of LINK Journal, we have been affected in the regular ways of meetings, interviews and studio visits being cancelled. This has been demanding a lot more flexibility and further organisation in time and space. Working in close collaboration with the Master in Design for Emergent Futures for a week has really helped us understand the many perceptions made by this complex situation, and to learn more about the collateral damages it had created. This project, along with its process, has created a common ground for thoughts, feelings and ideas to be shared amongst this supportive collective of creatives. All of these elements, amongst others, have contributed over the past few months, to the creation of a new narrative for the future of our society and the design discipline. This crisis has forced us to challenge our individual capacity to adjust, physically and psychologically, along with the infrastructure that was built to avoid this crisis.

How has the Virus Affected these Distributed Practices and Could Potentially Benefit Practices from the Micro, Domesticated Scale?

When it comes to a project such as LINK, starting remotely has helped us adapt seamlessly to this situation. If remote working is available for your practice then there is no reason to not do it. LINK have been talking to people in Barcelona, Melbourne, the US, Russia, everywhere. We have learnt to synchronise our work and have weekly meetings (amidst meetings with contributors and collaborators). Being two people working together, albeit remotely, has benefited us in the sense that it has become the most natural way to reach someone from anywhere, allowing us to communicate with ease. In the same way that small teams can remain agile and the problems will always arise with scale.

Equally, this crisis has forced us to be more aware of our capacity to adapt when confronted with reality. We now know that it is possible for a large part of the working population to work remotely and to stay in touch with people, but also learn to live with what is available nearby. This situation has opened a window to make decisions that can change the way we live. One example here in Spain, is the recent implementation of a universal basic income (UBI) amidst the crisis, changing for the long term living standards. We can also see now, more than ever, the benefits of being more self-sufficient or dependent within a small radius, for the consumption of goods and services. These recent changes will, if not now, in the near future transform the role and meaning of many practices, including design, and adapting them to these new realities.

Future of Distributed Design in Relation to Post-pandemic

Experiencing this pandemic has strengthened the belief that there will be a new normal. Even if it might seem like it, this sentiment of "nothing will change" will disappear and leave only hope for the generations to come. This emergency has given an opportunity for testing and to put in context some ideas that were thought to be too "futuristic". Now we are catching up with reality. The HDxHG project has also been an opportunity to bring into the conversation some fundamental issues and think about what to do if this pandemic was to happen again in the future? Will we be better prepared? It is time to create a new narrative redefining our norms and traditions within many of our practices.

What Does the Role of Design Play in This Scenario, but also Coming Out of the post-corona society? How Can Design Create long-lasting Change?

There are many factors— political, social and economic ones, that contribute to the implementation of sudden, recent changes, like the ones that are emerging from this pandemic. It is when ideologies and norms have been shaken in a situation like this, that design opens up new possibilities for the future and takes an important part in this process of transition. Design should say more with less — misinformation & data visualisation running rampant, which one of the students Andrea spoke about in her Hyper Domestic x Hyper Global chapter from a more interface point of view. Three-dimensional printing masks, how grassroots movements are moving faster than traditional manufacturers. But in the context of our practice at LINK and also the Masters, the role which designers take is that of storytellers – creating and building these preferable futures, daydreaming about these scenarios, asking the "what if" questions, and having to entertain all of these notions collectively. However, beyond the act of just questioning comes further investigation and taking action; communicating it to people, particularly as emotions and stories can last longer as it has been a trying time for everyone, and this is where designers can tap into this.

FABSCHOOLS - Maker Education from Home

André Rocha and Tiago Almeida from Politécnico de Lisboa

COVID-19 Poses Educational Challenges for Designers

The COVID-19 crisis couldn't be more devastating to the educational field. Learners, families and other caregivers were negatively affected by school closures. UNESCO estimates that around March 2020, at the peak of the pandemic crisis, 1.5 billion learners were affected by more than ninety percent of schools being closed worldwide (www.unesco.org). More than ever, educational strategies need to be adapted and evolved. The Maker community reaction in terms of the PPE Crisis in Hospitals proved the concept and importance of the Distributed Design (DD) proposal. But what about the implications on other areas? How will education be affected and change?

This extraordinary situation led to the adaptation of the Fabschools first activities, now focused on addressing the following questions:

- How can we create more resilient Educational Resources, beyond the digital content and tools exclusively aimed at screens?
- How can Maker Education, and other materiality-based learning activities adapt to these circumstances?

Fab Labs and Makerspaces are cumulative spaces of openness and education that empower a distributed model of design. Fabschools contribution was to come up with strategies that bridge the gap between the design community and the technologies, mechanisms and contents of Maker Education. On the other hand, designers can contribute to enriching the strategies and diversity of approaches used for education in such spaces. Designers are by far one of the best-trained professionals to make the most out of complexity.

Fabschools Project— Distributed Design for Education

Fabschools is in its essence, aimed at testing the robustness of the Distributed Design proposal and its values while addressing the COVID-19

home education context, by exploring diverse contexts where Maker Education can thrive and be useful.

Fabschools is also set on the premise that designers can become key actors in the educational field. These very same creative minds who work hard to tackle problems are now convened to address the application of Distributed Design to a Home Education setting.

Fabschools Deck - CC, Fablab Benfica.

By following its values, they should be able to propose a physical product or lesson, that addresses one or more Sustainable Development Goals (SDGs). Designing Open Educational Products and lessons that are supported by the Fab Labs (Makerspaces) and Schools ecosystem, but at the same time deployed and used at home is also part of the game. This challenge is posed to the design community in general through an open call (fabschools.pt) but also to our research team when scouting for projects, applications and best practices.

A Deck of Cards

As we kept identifying suitable characteristics from projects and initiatives that fit into the Fabschools call, it became evident that we needed to develop an evaluation system that would also rely on an open process and consequently on distributed design. The first tool being developed is a playing cards deck divided into four main sets: Openness, Ecosystem, Education, Sustainability.

The deck serves two purposes:

- The assessment of projects at any point of its development;
- As a co-creation tool, allowing interdisciplinary design teams to gather around a table and brainstorm their way to a solid set of design premises.

The entire deck rehearses a gamification strategy where points are attributed or taken if some characteristics are identified. The best score is meant to recognise the best Fabschools "Making Education Makers at Home" fit.

Openness assessment is based on a pool of intellectual property restrictions:

Firstly, by clearly setting the main objective of sharing from complete appropriation, allowing full flexibility of use to a simple non-restricted usage but not allowing any change or contextual adaptation. After that, our designer/player is invited to reflect on the way the work is being shared. Under what conditions? Highly inspired by the modularity of Creative Commons licensing, we transformed each restriction into a subtraction card (www.creativecommons.org). So, if a designer intends to impose a non-commercial or a share-alike limitation, the level of openness will decrease , and that restriction will lower the overall score. Lastly, we incentivised a reflection about how the work is being shared. The documentation media is essential, and there is no point in sharing a fully open work if no one will know how to proceed, how to adapt or if no information or source files are sufficiently available.

Education is an area where openness can play a crucial role. The success of many examples of Open Educational Resources (OER)[21] shared, translated, adapted and remixed throughout the world is the best example of its importance (www.hewlett.org).

Describing the Ecosystem is about mapping the stakeholders in the project. For the COVID-19 crisis context and the "Maker Education at Home" challenge, this stage will allow us to perceive how to get the product or lesson home, and even to figure out if it is a product aimed at "all homes" or whether just a few will be able to access it. Understanding who does what and through which channel that works or where resources are delivered is essential. Our proposal is to map the dissemination, and the commons or business model behind the implementation of the project.

Educational potential is addressed by looking at three main dimensions: context, educational output, and goals. Regarding context,

Fabschools Cards, CC, Fablab Benfica.

we expect to value products or lessons used both in formal education (e.g. kindergarten, an elementary or middle school, in person or remote situations) or informal contexts (e.g. community activities, workshop, free play, games or learning applications). Concerning the educational output, we are looking at how the product or lesson promotes explicit or implicit learning. With the third dimension— goals— we are looking to see if the product or lesson promotes learning of contents, subjects or techniques and/or development of skills.

Finally, the Sustainability set plays a double role in the overall assessment. If we look at it from the fabschools call perspective, as it serves both as the theme/content and also as a central value to any distributed design. To enable this, we designed a set of cards that invites the user to choose one or more SDGs that are recognised or perceived by the learner when following a lesson or interacting with a product. Parallelly, the designer needs to perform a sustainability evaluation of the project, mainly by looking at the life cycle of the product.

Talking to the Community

The first iteration of this “Creation Deck” led us to a set of workshops aimed at onboarding the community in the development of this tool, by calling various actors to contribute to its development. The first workshop was led by our core team at the last FabX conference. The tool was very well received and perceived, as well as the remote workshop format, based on the Miro App whiteboard. We believe that the format of the cards workshop can incentivise the generation of new DD for Education proposals. We also started a series of interviews with designers that we believe developed products or lessons which are sufficiently deployed and successful to test the efficiency of this tool.

The self-assessment component was particularly impressive with two projects: Alquimetricos (www.alquimetricos.com), a project we have been using as reference, and that inspired many of the premises we are associating with the “Making Education Makers at Home” call. Fernando Daguanno, the leading designer and activist behind Alquimetricos, got a maximum score. Besides that, his remarks and comments will be precious for the development of our next iteration. In his opinion, a strong point about Alquimetricos is the development ecosystem and the openness of this very same ecosystem. Fernando believes that the economic sustainability model is also a matter of design, which in their case is also documented and published under a Creative Commons License, allowing others to be inspired by it and apply or adapt it to their proposals. Of course, we are talking of a highly mature project that pinpoints most (if not all) of the Fabschools main goals.

Another interesting interview was the Mariana Costa e Silva one. Her project— “Faz com as tuas mãos (Do it with your hands)” derives from her designs to a workshop setting (www.marianacostaesilva.com/faz/). An informal group of community members and their children are invited to collaborate on the manual fabrication of her models. These models are precisely thought to apply the most basic methods of production, yet unfamiliar for most of the children. The educator and the under-12 learner are invited to experiment with the usage of manual saws, nails and hammers. This is particularly interesting from several perspectives: from the acknowledgement of the work behind an object, to confidence-building by using the tools that safety restrictions took away from the traditional school system.

But Mariana’s interview was particularly interesting for the openness debate and all the questions that she raised. Mariana’s anxiety about opening up her design source is similar to most of the traditional design education perspective, mostly based on the conventional intellectual property valorisation and economic model. In any case, she acknowledges the importance and impact of opening her work. Yet, some unsolved questions about the model remain.

Alquimetricos, CC, Fernando Daguanno.

The interesting aspect from a research point of view is that we might immediately find an answer by relating both interviews. In any case, it is very premature to extract any conclusions since the interviews and workshops will proceed to a more systematic phase. On the other hand, we find consistency and potential in the model we are developing, as well as the capacity of integrating other’s contributions. In any case, the Fabschools deck is a potentially Distributed Design[22].

"Faz com as tuas mãos" Chair, CC by nc nd Mariana Costa e Silva.

Next Steps and Goals

Fabschools is just starting. We believe to be following the dream of many others who like us promote Maker Education as a natural complement for the traditional school setting. Also, like many others, we were surprised by the crisis. It interrupted our everyday living and consequently, our way of educating and learning.

Incentivising and promoting DD for Education can't just be based on a static catalogue. Fabschools needs to support communities and platforms by supplying them with tools such as the Creation Deck or by disseminating the initiatives within partner schools and creating the ground for more successful project development. Fabschools should assume the role of field test facilitator by incentivising the creation of Fablabs or analogous structures inside schools where the impact of these projects in the educational contexts can be tested, observed and perceived.

It is also essential to acknowledge all the partners who are supporting the project. More specifically, Wikifactory[23] and the Fab Foundation, through Scopes-DF[24] who have been crucial to the success of the call. Their importance is infrastructural. We can't have Fablabs nor Fabschools without them. Our goal is to keep looking and partnering up with existing platforms, contributing to their growth. We still can't clearly define specific quality standards, nor best-practices in terms of OER in the field of Maker Education. Nevertheless, we are sure that this can't be studied without the collaboration of these platforms.

We believe that by iterating curation, dissemination and gathering data from local implementations and field tests, we will be able to produce recommendations and contribute to setting up best-practices in terms of Maker Education projects. Fabschools will want to promote more research and look at how educators or a community can make the best out of all resources available.

Finally, we expect to look at all this from a more profound research perspective establishing more international partnerships aiming at sharing knowledge and practices that articulate education and design.

Teaching Design to Distributed Students

Nat Hunter and Gareth Owen from Other Today

Other Today is a London based design studio founded by Nat Hunter and Gareth Owen Lloyd that promotes the power of distributed and circular design to radically change how and where we make things. While it is widely accepted that Distributed Design is a way to reduce the planetary impact of products, we also believe that it has the potential to create a fairer distribution of power and knowledge — distributed does not just refer to bits and atoms but also to the distribution of knowledge, power and opportunities. As a studio, our practice is about enabling; we enable people to invent tools, share knowledge, re-code objects, craft materials and create systems to challenge the status quo. We help organisations set up makerspaces, hubs and labs; and we encourage the tools, machines and inclusive programming that creates inspiring spaces.

'When lockdown happened, we were worried that we would lose opportunities for informal chats and that teaching would become isolated.'

We are passionate about creating opportunities for makers, designers and artists to develop new work and tackle real world challenges and in line with this, we run one of four vertical studios on the Product Design BSc at Brighton University. Our students have focussed on creating designs that could be made anywhere by anyone; experimenting with novel methods of digital and social making. This has meant adopting an open design approach with accessible local materials, clear and open specifications and an emphasis on making.

We have not been designing products, but interventions into global supply chains. We have been sharing kits, inventing tools, hacking systems, re-coding objects, brewing, melting and crafting materials.

In the first term, we visited a port where products arrive in this country and a waste centre where they end up. We completed a series of micro briefs that explored modifying existing systems and distribution methods.

The second term began in January with students leaving their comfort zone to have "non design" experiences. Some learnt new skills like skateboarding, others volunteered or cleaned their local area. We hacked products, interviewed experts, experimented and iterated and throughout, our studio has collaborated with the open design platform Wikifactory (wikifactory.com/+othertodaystudio) to share these ideas with a global network using video, open design instructions and social media.

Locked Down and Cancelled

Lockdown came late to the UK. Whilst Europe was singing from balconies and printing PPE, in March Other Today was still making the trip from London to our tutorials in the Fab Lab at the University of Brighton. At the time that lockdown was announced, our students had been preparing to turn the Lab into an exhibition space; we had built a system of CNC-cut pegboard panel displays and their projects would be on display at the work in progress show. The event would have seen hundreds of guests visiting our studio followed by a fundraising afterparty to raise money for the degree show. In hindsight, the timing of the cancellation was lucky and we narrowly missed becoming superspreaders! We were all sad to have lost the opportunity to see the projects in one place. Heading home that night we did not realise that lockdown would mean not coming back for almost a year and, for the final year students, the cancellation of their graduation show.

In the UK, people were restricted to one hour of exercise per day and only allowed to leave the house for an essential shop — an experience that quickly became apocalyptic, with empty shelves and snaking queues. Student morale was understandably low in this climate but while we were all disappointed not to meet and make together, by creating projects designed to be manufactured on Fab Lab machines and by other people, the studio had been set up well to cope with the restrictions of the pandemic.

The Virtual Studio

Studio culture, the experience of being around your peers whilst making, is so important when learning creative subjects. When lockdown happened, we were worried that we would lose opportunities for informal chats and that teaching would become isolated. Up to that point, all our teaching had been done in person. We needed a way not only to video call but to collaborate and participate. We tried what felt like every video chat software on the market and, like seemingly most of the world, we signed up to Zoom as our main video conferencing platform; it's grid format best replicating a classroom environment and the ability to create breakout rooms perfect for tutorials and group work.

Even the customisable backgrounds added a semblance of identity to the blank digital space and allowed both students and staff a degree of privacy if required.

Lockdown coincided with the four week spring break, but we had a hunch that it was important to keep a thread running through these weeks, so we arranged weekly check-ins. Only an hour long, these check-ins gave everyone a chance to just meet up on Zoom and chat, to see other students and share what they had been doing. It kept an element of studio camaraderie going, and students would join from their bedrooms, their kitchens and some from their phone as they helped relatives do shopping. We found that for some (not all) of the students, when you're on your own in your bedroom, just seeing other faces and having a chance to say what you're up to is a real bonus.

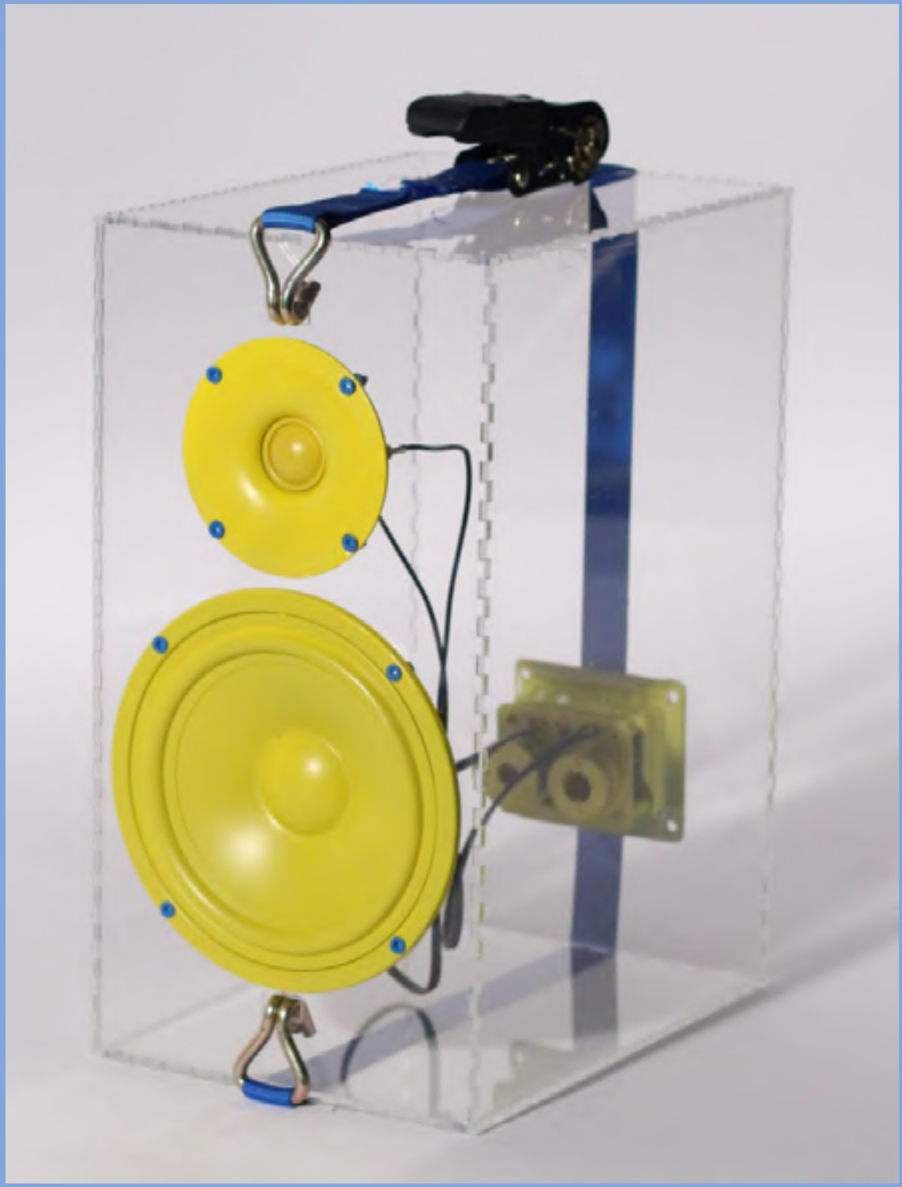
Although Zoom helped us communicate, we also needed a way to collaborate. In the app Miro, everyone can see their peers' cursors moving around a whiteboard, placing images, links and post-its. Miro generously gave us a free account, and we began to discover the joys of having our research, slides and workshop materials all in one place. For teaching the more complicated concepts (for instance, doughnut economics and how to measure social impact), we created a visual mindmap of our thinking, used frames to turn the mind map into a slideshow, then set up post-it areas further down the board for a more hands-on thinking session. We broke out into three Zoom Rooms with a tutor in each one, and workshopped student's projects for them to discover how they might measure social impact.

'Studio culture, the experience of being around your peers whilst making, is so important when learning creative subjects.'

Resourcefulness and Resilience

In our first session, after the initial shock of lockdown had worn off and we had all finessed our Zoom backdrops and and home studio setups, we encouraged the students to think about pivoting their projects in the context of COVID-19. Did the project take on new meaning? Could it be done at home? How could the projects address this new situation? With Brighton University industrial workshops out of bounds and the city shut down, many of their ideas were no longer doable. A project turning waste from a local brewery into sunglasses could not go ahead because the business had to close and another based in Mens' Sheds makerspaces had to rethink how to engage in participatory design in a time of social distancing.

However, the DIY ethos of the maker movement served the students



Isolate Radio, Dan Balint, UK, 2020.

OFFCUT, Ben Palmer, UK, 2020.

well and they showed resourcefulness and resilience in the face of the shutdown. One group clubbed together to buy cheap home 3D-printers (and fixed an old Ultimaker 1) and organised themselves to print each other's prototypes. Many changed their projects to directly contribute to their community, some built new tools at home and others turned their projects into kits to create new ways of working with people at distance. Throughout all of this none lost sight of their original brief: to create a project that can be made anywhere by anyone.

The Changing Definition of Community

"In a changing world everyone designs: each individual person and each collective subject, from enterprises to institutions, from communities to cities and regions." (Manzini, 2015).

In the changing world of COVID-19, Other Today studio member Megan Stratford wanted to create a way for people to communicate through collective absence. Pre-lockdown research into interventions such as Guerilla gardening and yarn bombing led her to design Comunicare, a simple kit for people to share loving messages with one another during the lockdown period. Megan shared the design for the woven net on Wikifactory and people in her local area began to follow her tutorial and share messages with vulnerable friends and family and show support for key workers. During a time when people could not meet, this project addressed the changing definition of community, while boosting the morale of individuals. It created an opportunity for people to do some hands-on making during isolation, allowing creativity to fill the space made by the absence of socializing and leisure. The project was picked up by the local news and multiple Communicare nets have been made around the UK.

Dan Balint had been experimenting with new materials and discussing circular economy with local businesses when lockdown started. He struggled to continue with the work he had planned and after returning to his family home, he wanted to pivot to do something that would help others through the pandemic. He and his friends in similar situations felt demotivated by the lack of structure to the day. He had an idea to create a radio station that can be hosted by anyone, anywhere at any time using just a microphone and computer. It could be a platform where anyone could drop in and share routine and companionship. He developed a set of instructions, a website and a system so that DJs could self organise into the timetable and the radio could run itself.

Daytime programmes included music and interviews about distributed manufacturing and new materials. In addition to this, positive audio cues are broadcast throughout the day; encouraging people to drink water and go outside to exercise. In the evening, live DJing had an accompanying video platform to bring people together online. Over a period of two months, the platform has developed into a community of regular lockdown listeners, music enthusiasts and talk show hosts from over 30 different countries, all helping to keep each other afloat during these difficult times.

Kits for Socially Distant Interaction

How do you make furniture when the wood workshop has been shut down and you can't buy tools or materials? Ben Palmer had been researching alternatives to flat pack fast furniture before lockdown and was collaborating with a CNC workshop to design a method of using their plywood offcuts to make new products. Post-COVID, the project became OFFCUT and focussed on teaching people skills to build their own DIY furniture. The stools are simple to make, using only one shape with varying lengths, that can be easily cut from awkward offcuts of wood. The aim is to develop people's confidence in making, encourage an appreciation of waste as a resource and to enhance their skills and the likelihood of them continuing to participate in making. To get around the restrictions, Ben hacked an IKEA stool into a bike rack and used his allotted one hour of exercise to cycle to local workshops and collect materials. He then packaged the pieces and cycled them to people's houses, dropping the package off on people's doorstep who then followed his instruction video to make at home.

Coronavirus created a need to control objects in the world without touching them so Joe Lyons asked the question “How might we control the world with our eyebrows?” Like Ben, Joe pivoted to an open-source toolkit for people to learn how to control the world with their face from home. He developed a physical set of parts, designed as an educational tool and a digital resource which allowed people to create expressive new interactions. Frustrated at the level of interaction he was having with his friends, he created www.eyebrowprong.com a game of pong that is controlled by you and your friends faces.

Workshops for the Home

Students responded to the closure of the workshops by building their own making spaces and inventing new, accessible tools. Markos Georgiou created Biogun, a handheld extruder that offers new ways of making with biomaterials. In the UK, we were only allowed to go to supermarkets to get essentials, for Markos the cheap electric screwdriver in the central aisle of Aldi was an essential. Using bits of plumbing and 3D-printed parts he hacked the function of the drill to become a homemade extruder. Combined with recipes from the Materim website, the Biogun provides new and fun ways of exploring biomaterial forms beyond the usual flat sheets.

When Lawrence Parent had access to the workshops at Brighton University, he was spending time in the engineering department’s concrete lab, using their massive steel pressurised moulds and experimenting with firing clay soaked loofahs. Lockdown put the brakes on this project but he was lucky enough to have a garden and friendly neighbour with a leftover bag of cement — enough to build a casting workshop in his back garden. Despite the situation, he managed to iterate hundreds of his “Living Blocks” and developed them into a recipe shared on Wikifactory. The bio-receptive building blocks can support plant and insect life. By hand making moulds in his back garden and filling them with ice, balloons and out-of-date tomatoes, Lawrence was able to create a complex form suitable for plants to live in. Because of the limitations, his final instructions for distributed design are easy to follow and really accessible — you can’t help but wonder whether lockdown made this a better project!

A New Normal

In 2017, we curated an exhibition called A New Normal. It brought together makers working in distributed design who had created real products that could be shared digitally and made locally. We were optimistic when we chose that title, excited for the possibilities of theory made real. The phrase has become the catchphrase of the pandemic but hints at an uncomfortable permanence for this situation.

We have been teaching our new normal of distributed design and seen it prove to be a suitable approach to the global new normal we find ourselves in. We are proud of what our students have achieved, and while we set out pre-covid to teach resilience and resourcefulness as skills for this rapidly changing 21st Century, they were thrown in the deep end. Most of them surfaced quickly, pivoting their projects, supporting each other and did the best they could. However, we did see a major challenge of socio-economics, with our students in varying degrees of comfort and support. When one student is at home with plenty of space, a garden and a workshop, and another student is sharing a house with multiple generations, all shielding, no broadband, and also working for money — the students are not learning on a level playing field. Although we did our best to support them, we did see some dropping off in attendance and others struggling to keep up with the work. This massive test of remote learning has shown how the physical university environment can go some way to compensate for inequalities. COVID has been a moment to reflect on the human aspect of distributed design, yes a design can be made anywhere by anyone — in principle. But not everyone has access to the tools or space to make. Many of the students tried to address this with simplified workshops and DIY methods. But is there a risk here of distributed design only being suitable to either simple DIY projects or complex digital fabrication? Equality is not distributed, design needs work harder to not just simplify products but expand access to the skills and tools needed to make them. The next academic year will not be “business as usual”, and so we need to learn from this experience and to make sure ALL of our students can build the resilience that comes from a maker mindset.

Living Bricks, Lawrence Parent, UK, 2020.

Fab City & Cosmolocalism (Be)for(e) COVID-19

Lucas Lemos from the Tallinn University of Technology

COVID-19 has disrupted the global value chains, bringing to the spotlight the weaknesses of globalisation. Unavoidable by design, the growth-at-all-costs principle at the core of the current global economic model is unsustainable for the planet. On one hand, the global production and distribution system presents several issues:

- It is too costly; as it entails very high costs to human and animal societies and to their environment. Societies are forced to overspecialize on their economic functions to adapt themselves to specific parts of the global value chains. The most notorious unbalance comes from the unequal distribution of the benefits derived from the social and cultural production of the conditions for a community to act as a cog in the global chains. We can call this the appropriation of the "positive externalities" produced by the community. The environment is deemed as "no one's land" and suffers great degradation under the imperatives of short term economic incentives and the lack of long term regenerative actions, called in economics "negative externalities".
- It is too unequal; as the parts of the value chain that are closer to the provision of materials and its manufacture are receiving a small part of the benefits, while the parts of the global value chains that are closer to knowledge-embedded immaterial activities as design, branding, research and development (R&D), marketing or sales are getting the highest retributions. This effect is called "the smiling curve".
- It is too weak, or wicked; because it can be interrupted by multiple factors at every step of its long and linear assembly line structure; it has to deal with multiple national and local jurisdictions; it makes our lives overly dependant on the uninterrupted provision of goods over which we have no control whatsoever; and in the end the whole process may come to halt when the unexpected happens, leaving whole populations unsupplied and without the knowledge and the means to re-supply themselves using their own productive capacities.

On the other hand, there are strong contradictions and unbalances in the global value chain:

- The global territory is divided into national states, and the benefits of their economic activities are mostly measured by indicators like the Gross National Product (GDP), which is the total value (in money) of the goods produced inside one state during a fixed period of time, but the main actors of the global value chains are multinational corporations, whose value is measured by the future expectations on profits (stock value) and the reach capacity of the brand (capitalisation).
- Most states constitute mere steps and stops in parts of the global value chains, and they count their economic performance backwards (what has been produced). Big multinational corporations, mostly based on powerful states, pervade the whole global value chain, while they count their value forward (future profits).
- Local communities (villages, towns, cities) are caught between the global territory sovereignty of states, that collect taxes and impose regulations upon these communities, while they are economically dependent on the global value chains pervaded by big multinational corporations. Between the backwards accounting of states and the forward prospects of corporations, local communities have to produce for both entities in the present.

'Having the sustainability of local communities and their environments on the focal point, the more valuable designs would be the more sustainable ones.'

But the same technologies that provide the conditions for a Globalization are also the cradle for alternative paths to organise a hyperconnected world. Although global value chains are mostly linear, hierarchic, and extractive, the technological infrastructure enabling such long and complex lines of production and distribution is based on completely different principles. The main infrastructural element of the Information and Communication (ICT) economic paradigm is the Internet. Its performance and reliability depend on a distributed network of peers, where each peer exchanges information with all the other peers on the network.

Peer-to-peer (P2P) practices are one of the more salient aspects of distributed networks: the network effect, where the value of the information exchanged, and the value of the network itself increases with the number of peers in the network. In P2P networks, the value of the information produced augments through collaboration. The more open, accessible and modifiable digital information is, the more digital information is produced in the network.

'For communities to locally produce material goods efficiently, physical products should follow open-source principles similar to the ones applied to the digital commons'

The second key feature that the Internet is providing is called "digital commons". The Commons are resources shared by a community that can be accessed and used according to a defined set of rules provided by the community itself. Digital Commons are digital resources under the same conditions. In the same way that the network effect is the "superpower" of the distributed networks, the digital commons have a unique characteristic: they are the resource and the product at the same time.

The capacity of distributed P2P networks and digital commons to unleash the hidden potential on the Internet and digital production is tangible in the case of Wikipedia: a distributed community of content providers acting under shared rules have created a vast and ever-improving encyclopedia that is the most consulted digital source of information almost (see the case of China) everywhere. These communities are globally distributed and operate in a different way to states and corporations.

The power of P2P networks and digital commons applied to material production has been observed in makerspaces (Niaros et al. 2017). In these places, the local communities have access to means of designing, producing and repairing tools, products, and other crafts while providing services, education and support to community members. In makerspaces, local communities enhance their capacities by improving the productive capabilities of its members. The usual outcome is local resilience and bottom-up innovation.

But as obviously as capacities increased in makerspaces benefit the long term sustainability of the communities, the public and private sectors usually fail to recognize the long term benefits of having resilient and sustainable communities. 2020 may be the year that this situation changes for good.

Applied to the problems of global value chains, we can see that instead of linear, hierarchical and extractive, P2P networks using digital commons are distributed, horizontal (democratic), and generative.

Some initiatives have been researching and innovating in a post-globalisation scenario organised around distributed networks of production and global digital commons.

Cosmolocalism[25] is a way to connect local communities in distributed networks based on global digital commons (Manzini 2015). Globalization separated production and consumption; cosmolocalism aims to bring them closer together, at the local level. Cosmolocalism inverts also the economic perception of globalization in another aspect: instead of treating material resources as infinite under a profit-seeking short-term perception, and treating digital information as finite and restricted, secluding it behind restrictive licenses, cosmolocalism treats digital information as limitless, due to its near-zero cost of replication, and it treats material resources as finite, as we very well know by the incipient deforestation of the planet and the increasing difficulties extracting fuel fossils from the underground.

Global value chains are radically reorganised in a cosmolocal fashion: the design and knowledge is produced and accumulated as global digital commons, available to anyone to access, study, modify and produce it, while the fabrication is performed using locally available material resources in a closed circular loop.

Bauwens, Kostakis and Pazaitis (2019) propose a three-level ecosystemic model for such reorganisation of the productive forces:

- Makerspaces would be the new space of production for local communities, that are here called productive communities, where community members can learn how to prototype, iterative design, experiment with different manufacturing techniques and materials, use collaborative practices to upheave grassroots innovation, and a hub for re-imagining new functionalities for the already existing production capacities of the area.
- Some members of the productive communities gathered around makerspaces would form entrepreneurial coalitions to address specific economic activities while providing sustainable business practices.
- For-benefit associations under different non-profit statuses (NGOs, cooperatives, foundations) would manage the global digital commons as shared infrastructure, providing solutions for the management of the common infrastructure that includes open repositories, licenses, certifications, standards, distribution of resources, and generally setting up community rules for the productive community and the entrepreneurial coalitions to access, use and (re)produce the digital commons and the local communities.

How is Value Created in Cosmolocal Networks?

First, the economic activities are not oriented towards profit maximization, but to address the needs of the local communities and its members. Value is produced by adapting global digital commons, as design, to the local context, and by manufacturing the solutions locally. This way, instead of a global chain of value that moves profits towards the top of the chain, a circular mode of production that retains material value inside the community while contributing to develop the global digital commons.

When production and materials are circulating locally in a closed-loop, there is a turnaround on globalization and lack of incentives for global corporations to take care of the localized negative externalities that they produce. Communities can choose to cut down the negative externalities in their environment by adopting clean, green sustainable practices. Instead of profit-driven negative externalities produced by extractive practices from rootless gigantic corporations, benefit-driven positive externalities produced by generative practices from grassroots small communities.

Second, having the sustainability of local communities and their environments on the focal point, the more valuable designs would be the more sustainable ones: simplicity of the design, that would allow an easier reproduction differing local environments; frugality in the use of materials, energy, and other costs; durability, because when there are no expectations of short-term profits but long-term benefits the products should last long and easy to repair; reusability, by adapting the product to new functions and needs, or by reusing its materials. Thus, designs with high sustainability features would be prefered, and R&D investment in good design would pay off long term by the recurrence of its use by the local communities.

Third, it needs a way to separate good from bad designs. Objective and subjective evaluations should be combined to provide an overall positioning of the designs. The same way we have certifications of energy efficiency for lamp bulbs and refrigerators, digital design should be open for testing and measuring, while keeping into account the users and producers opinions on the design. By correct recognition of the authorship of the designs through licensing, and with a shared set of rules on how to retribute to the designer with part of the value created in the local community that uses that design to manufacture the product.

Open-source is one of the key principles for a cosmolocal model to make the best of distributed network capacities. The more open the knowledge is, in the form of global digital commons, the easier for every member of a productive community to produce something new, and the faster increase of globally shared knowledge. But open-source practical applications have been limited to digital information for too long. For communities to locally produce material goods efficiently, physical products should follow open-source principles similar to the ones applied to the digital commons. The design alone does not suffice to reproduce locally material products.

“Open-source hardware (OSH) is hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design” (OSHWA 2020). While OSH didn’t reach a sufficient level of maturity yet to be used as the cornerstone of a cosmolocalism mode of production, recent advances like DIN SPEC 3105, which is the first open “source standard ever published by a national standardisation institute” (Bonvoisin 2020), provide a set of minimum requirements for documentation of OSH design and a community-based assessment protocol to provide certification.

'Both shared digital and physical spaces are needed for communities that want to address their needs by themselves'

From a cosmolocal optic, distributed design is connected to:

- Global digital commons, where open repositories of design are accessed and used according to open-source principles.
- Sustainable design, which is based on positive externalities generated through distributed collaboration and the use-value added in a P2P network of designers.
- OSH, as the practical production form of the products and tools that have its value embedded in its distributed design.
- Makerspaces, as the places where communities can manufacture, experiment and prototype, i.e., where distributed design is put into practice, iteratively improved and tested.

By using distributed design as part of a cosmolocal approach, every locality is:

- A potential co-designer with other localities in the network.
- A contributor to the global digital commons of design.
- A partaker on the positive externalities generated through the global digital commons of distributed design, as ever-improving designs are openly available.

Fab City condenses the main ideas of cosmolocalism with an action plan: to make cities produce everything they consume by 2034. The underlining motto is “locally productive, globally connected self-sufficient cities” (Fab City Whitepaper, 2016). Instead of making cities part of linear global value chains where products enter from one side and trash exits from the other (planned obsolescence and all), bring sustainable production back to the core of the cities, while creating a circular economy model around makerspaces. Knowledge would be shared among the cities: best practices on specific areas, from re-use of materials to community management, would be part of the global digital commons.

Each city could somehow specialize in deepening their knowledge on the parts of the urban circular economy that best suits their available capacities, providing more value for all the other cities while benefiting from the same process in other areas of activity in which different cities have bigger capacities. This way, each city can easily generate a local sustainable circular model of production based on the application and customization of global digital commons produced through the experience and experimentation of each member of the network.

Distributed Design Applied to Cities

FCGI consists of three parts:

- The Fab City Network, that is the global network of cities that are part of Fab City.
- The Fab City Collective, that is a group of individuals that are the core propellers of Fab City while being dispersed throughout Europe and the world.
- The Fab City Foundation, which is based in Estonia, a country that provides the digital infrastructure for FCGI to operate globally and in a distributed fashion.

Bauwens, Kostakis and Pazaitis (2019) cosmolocal ecosystemic model can be traced across the Fab City Global Initiative (FCGI):

- The productive community is distributed among the cities: every person can benefit from and contribute to the commons locally, by engaging in activities that use and produce commons based on distributed design in the urban space, and digitally, by using and contributing to the global commons of digital designs.
- The entrepreneurial coalitions are also formed locally, into each city, and globally, as people and organisations from each city can engage in shared enterprises. Here, the Fab City Collective has a leading role by creating some of these global enterprises among themselves and finding the best practices to work together.
- Fab City Foundation has the role of for-benefit association taking care of the infrastructure at a cosmolocal level providing standards, certifications, coordination, guidance, and safeguarding the part of the digital commons connected to the digital infrastructure.

By seeing Fab City under a cosmolocal prism, some lessons can be provided:

- From the printing press to libraries, to the internet, to makerspaces: distributed information among communities is about spreading ideas and values, in horizontal and democratic ways — generating a shared sense of "reality" that can be adapted to local conditions. Both shared digital and physical spaces are needed for communities that want to address their needs by themselves.
- To activate the hidden powers of well designed and organised networks of collaboration, the shared values are the driven force, and the (interpersonal) trust between the members is what makes the difference for the community to remain together in the long-term and accept the burdens of voluntary work and resources invested in the community without a monetary compensation in mind.
- A cosmolocal approach to closed loops of material production into the cities can potentially provide local resilience and sustainability for communities that are currently over-dependant on global value chains for their short term subsistence.
- Distributed design also allows cities and communities with lesser knowledge in specific areas of manufacturing or undeveloped productive capacities, to use and adapt designs tested and generated by the use of collective intelligence from different disciplines of work.
- Adequate governance is key to actualize the capacities of distributed collaboration: from decision-making protocols, licenses, different levels of involvement, or community accountability to equity-based access to the available resources.
- The shared digital infrastructure, governance protocols, and digital commons of design from a network of cities should be maintained and safeguarded by a neutral non-for profit entity with a distributed and global approach.
- The quick spread and open access to digital design combined with localized manufacturing facilities operated by the communities themselves greatly help to provide agile responses locally to unexpected disruptions of the global value chains like the one caused by COVID-19.

STYKKA— Designing for the Unknown

Mads Ohland-Andersen from Dansk Design Center

Stykka, Copenhagen, 2020.

Stykka is a Danish furniture brand that has set out on a journey to digitalise the way we design, manufacture, and buy furniture for office spaces. By utilising the newest technology to create a digital manufacturing platform Stykka produce high-quality designs composed of responsible materials directly from the factory to the consumer.

The year 2020 was supposed to be the year where Stykka would be positioned to deliver high-quality furniture for even the biggest companies in Denmark. After years of preparation Stykka now had the distributed production platform that would allow them to deliver high-quality furniture for all types of offices and companies.

Then on a Wednesday evening, everything changed. From one day to the other Denmark was in full lockdown. Everybody was sent home from work. For Stykka this could only mean one thing. Cancellations. In times where nobody works from the office, nobody buys office furniture.

“It became obvious that we needed to hack our own behaviour. You can choose two ways. Take cover or face the storm and make the best out of it”

Stykka chose the last option realising that the economic consequences would be difficult to cover, Stykka chose to look elsewhere for business drivers. With the usual restraints out of the way identifying the problem became the new centre of attention. By choosing to focus on pressing problems new opportunities immediately appeared.

“In every vacuum new needs and new opportunities arise”

With this new mindset, it became even more evident to focus on internal expertise. Combining the element of societal needs and company skills would turn out to be an effective formula for success. By focusing on company skills, it was possible for Stykka to identify a key problem, a need to be solved. The result, a cardboard table for home offices.

Producing and Innovating during COVID-19

Facing the new reality of a society in lockdown, home offices became the new normal. Most people had the challenge of needing two functional workplaces at the same time. Yet a lot of people struggled to create even one decent office space. The need for rethinking was evident.

“Hopefully this is a temporary situation. In the interim, how can we come up with a sympathetic answer that will not turn out like trash when this is all over?”

For Stykka it was important to turn things upside down and come up with an alternative answer that responded to the unique need of the home office. Quickly Jarl Vindnæs (CEO) and his team decided to use recycled cardboard for their new temporary workstation. Other design principles followed, and the design team chose to focus on mono-material for recycling purposes and a flat-packed design that would enable regular post services to deliver the product right at the customer's doorstep.

Despite all this, the biggest shift was to sell directly to private customers. Going from serving large corporations, this posed a major change in Stykka's business model. Approaching private customers meant that they had to reimagine the entire online platform. Instead of online redesigning the company website, Stykka went even further and chose to reimagine its relationship with customers. Stykka was at this point designing a brand new product for an unknown customer segment in an uncertain future. To tackle this uncertainty Stykka decided to Open Source the cardboard table and ask the customers for help.

"What happens with Open Source is that the product gets a life of its own. A life that's bigger than your own company. From the moment you set aside your ego and put the product at the centre, that's when people start engaging with you."

By Open Sourcing the product, Stykka managed to create a whole new relationship with its customers. Going from delivering products, Stykka now had customers posting assembling and hacking videos. The customers began to form a community adding new features and feedback every day. Stykka had previously developed an underlying on-demand production infrastructure, now allowing them to fully leverage the customer inputs and instantly produce new versions of the product.

"We are able to constantly print the best imaginable version of a new product. We think this will be a key parameter to prepare for a changeable future"

This new business approach was not limited to the design of the new cardboard table. Going Open Source has entailed a fundamental change in the way Stykka conduct their business.

Changing the Business— a New Mindset

Traditionally Danish design is characterised by fine details and years of development with the aim of creating instant classics that will remain relevant for the next 50 years.

"We believe society changes; in the way we work and in the way we live. Our products and designs have to be adaptable to this change to stay relevant."

From the experiences of the cardboard table, a new design philosophy emerged. Going from products to platforms, Stykka now develops designs with the simple aim of being non finished, non-static and future-proofed.

StayTheF***Home Desk, Stykka, Copenhagen, 2020

Chapter 07

CLOSING

There are similarities between the spread of COVID-19 and the rapid uptake of design during the pandemic. The mobilisation of designers and makers to the crisis can be seen to have spread as infectiously as a virus would. Hence, the name and title ‘Viral Design’. The article in this chapter reflects on the powerful resilience of Fab Labs and makerspaces which in the face of crisis, are poised with the mechanisms to prototype, document and share intelligent responses and design ideas. The closing chapter contains illustrated results from a COVID-19 Fab Lab manufacturing survey and contributions from Enrico Bassi.

COVID-19 Survey Fab Lab Manufacturing Results

We sent our survey out to roughly 65 labs in the Fab Lab Network, all of which are involved in the Fab Academy and Fabricademy distributed educational programs

Fab Foundation on the 26th of May

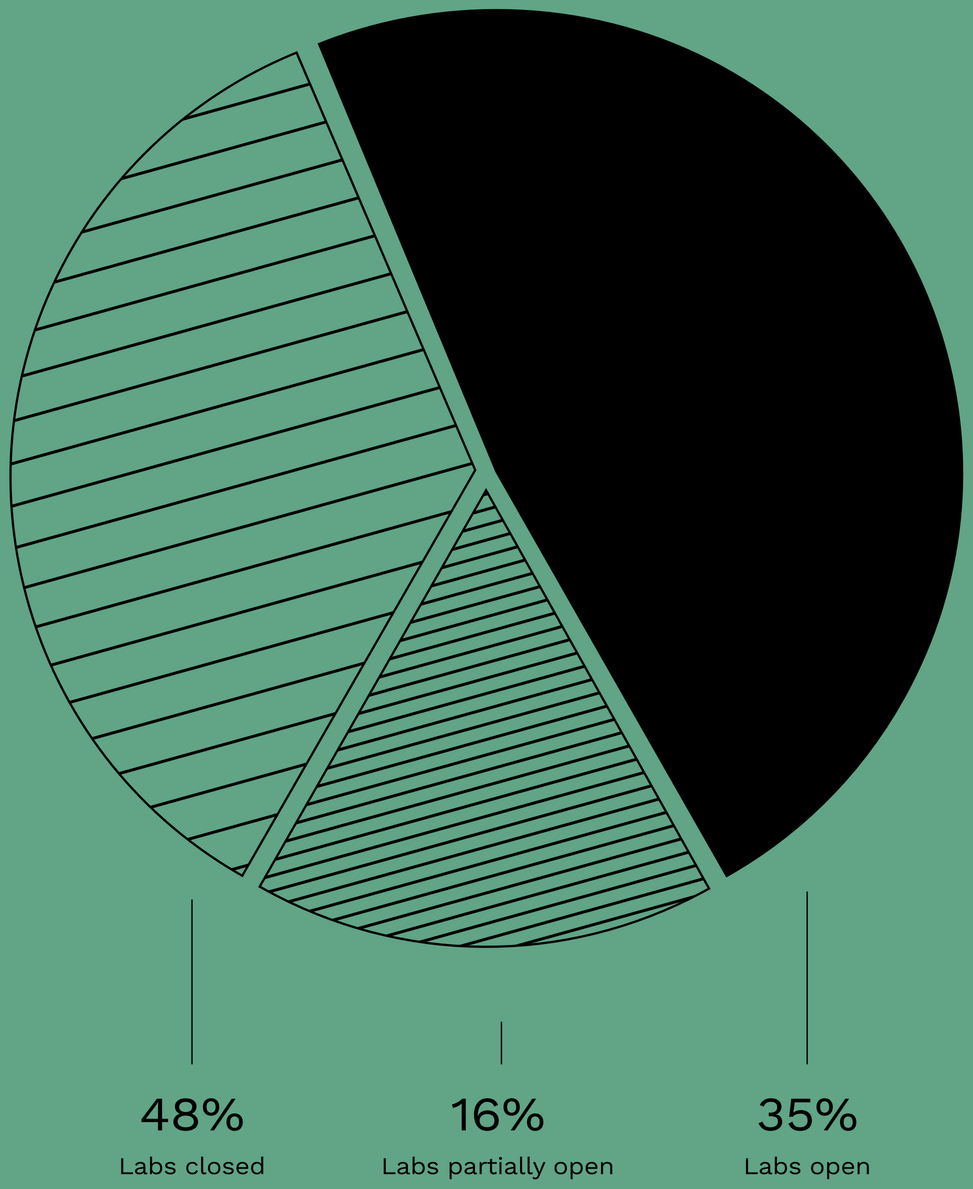
Countries where the labs are located

Argentina	1	Jordan	1
Armenia	1	Mexico	2
Bangladesh	1	Peru	4
Brasil	4	Poland	1
Canada	2	Portugal	1
China	2	Rwanda	1
Finland	1	Spain	3
France	2	Taiwan	1
Germany	1	United States	5
Greece	1	Italy	2
India	3	Latin America	1
Japan	2	Fab Community	

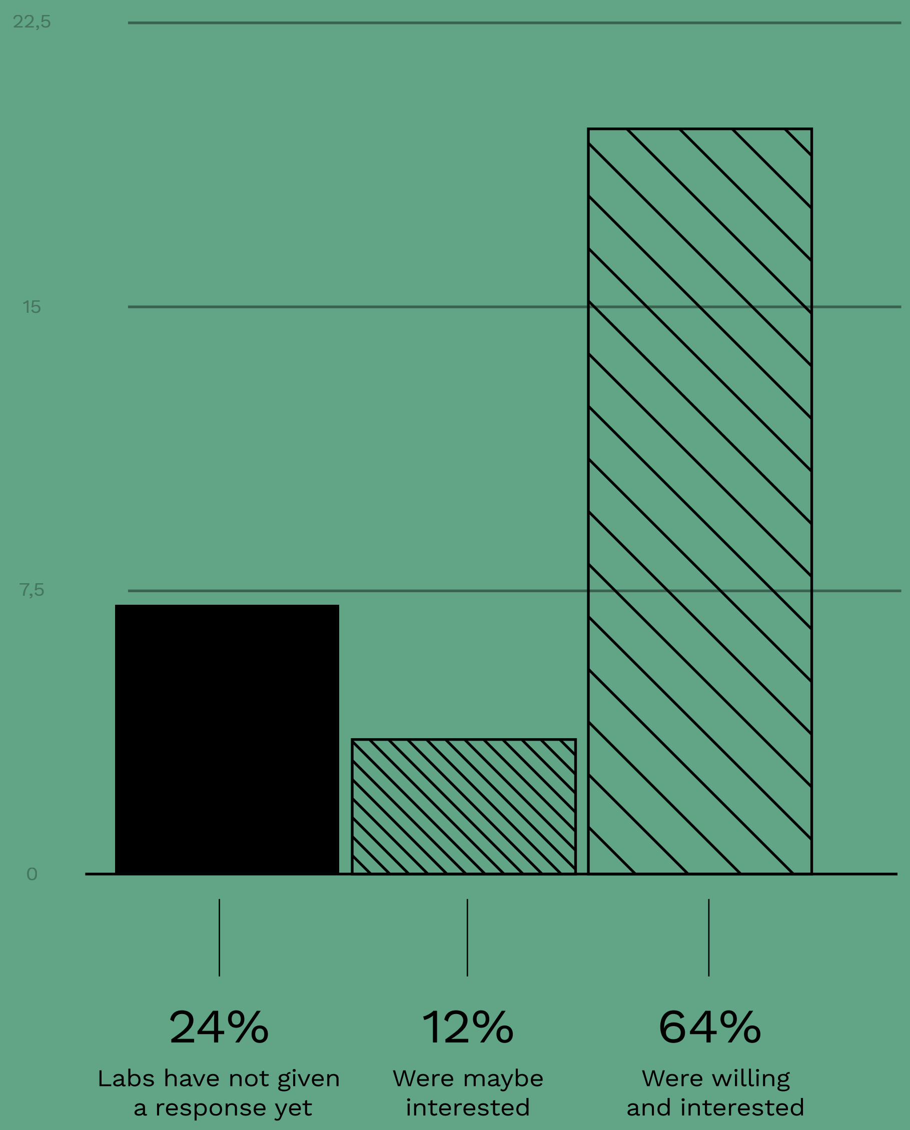
Responses from 41 Labs

Aegean Idea Lab – Agrilab – Artisan's Asylum – BSDU FabLab – CIT Fab Lab – Deusto FabLab – DIlijan Fab Lab – Echofab – Fab Lab Aachen – Fab Lab Aldeias do Xisto – Fab Lab Chandigarh – Fab Lab Dhaka – Fab Lab ESAN – Fab Lab León – Fab Lab Madrid CEU – Fab Lab Oulo – Fab Lab Puebla – Fab Lab Recife – Fab Lab Rwanda – Fab Lab Tulsa – Fab Lab UCAL – Fab Lab UTEC – Fab LaT – Fablab Irbid – FabLab Kamakura – Fablab O Shanghai – Fablab Powered by Orange – Fablab Puebla – Fablab Taipei – FabLab Vancouver – Fundación FabLab Córdoba – Impossible Objects – KromLabòro Caserta FabLab – Lena Park Fab Lab – Olabi – Opendot – Shenzhen Open Innovation Lab – Vigyan Ashram Fablab

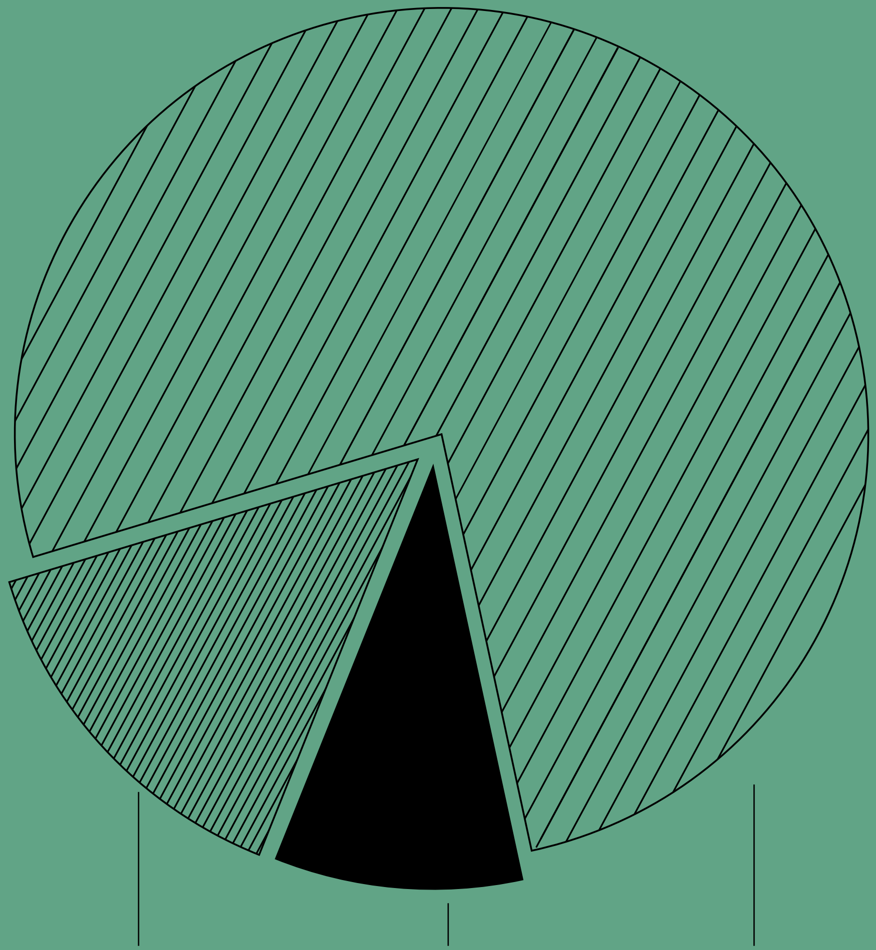
Is your lab currently open?



When asked if they were interested and willing to participate in a distributed manufacturing process for global COVID-19 response



Is your Fab Lab making any personal protection equipment (PPE), diagnostics supplies or other medical equipment in response to COVID-19?



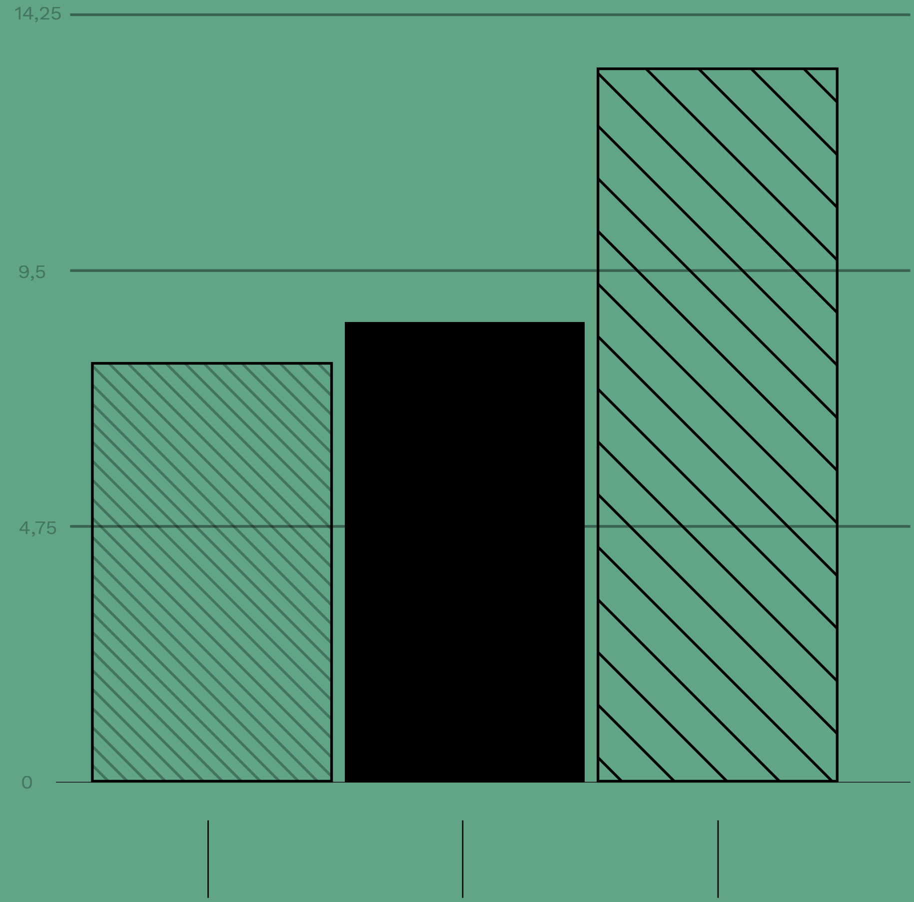
14%
Making PPE at the lab

10%*
are not making PPE or other medical devices currently

76%
are making PPE through a distributed network lab

* 1 of the "No" is making masks only for personal use

When asked whether labs would be willing to make a different design than what they are currently using

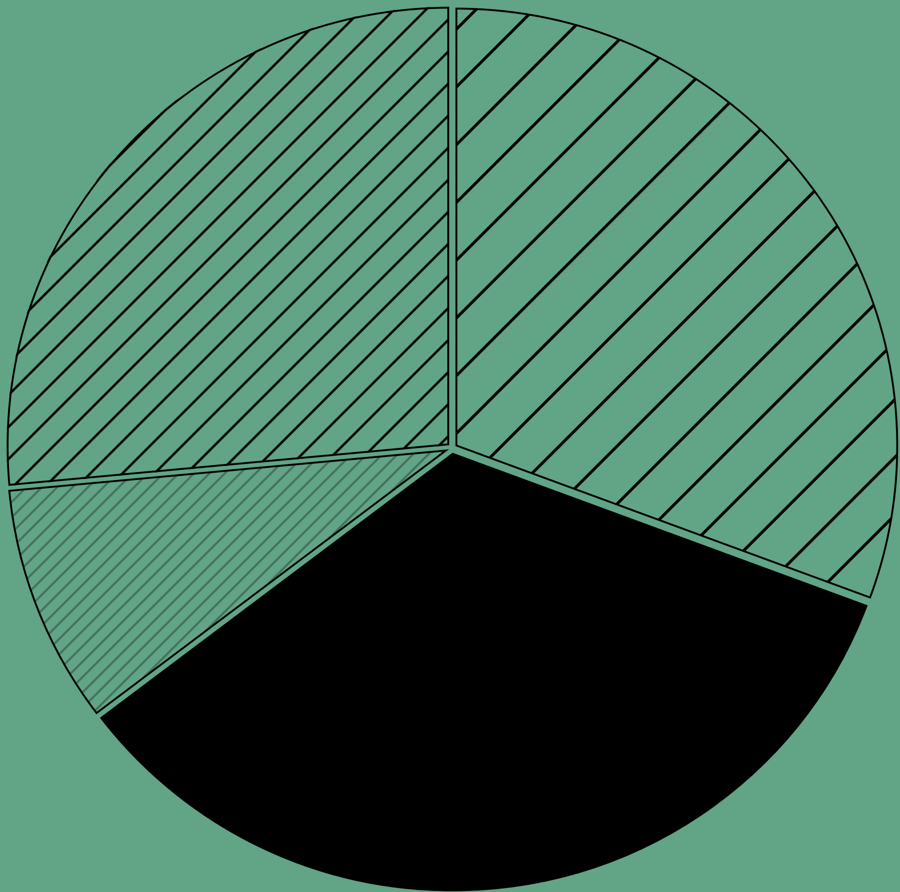


26%
Labs have not given a response yet

29%
Said maybe

45%
Said yes

When asked if they have the capacity and interest to have volunteers at their lab



31% said yes

10% labs have not given a response yet

26% said maybe

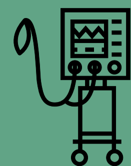
33% said no

What items are you currently manufacturing? (this is from all of the labs)

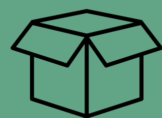
29 Face shields

03 Gowns

12 Surgical Masks



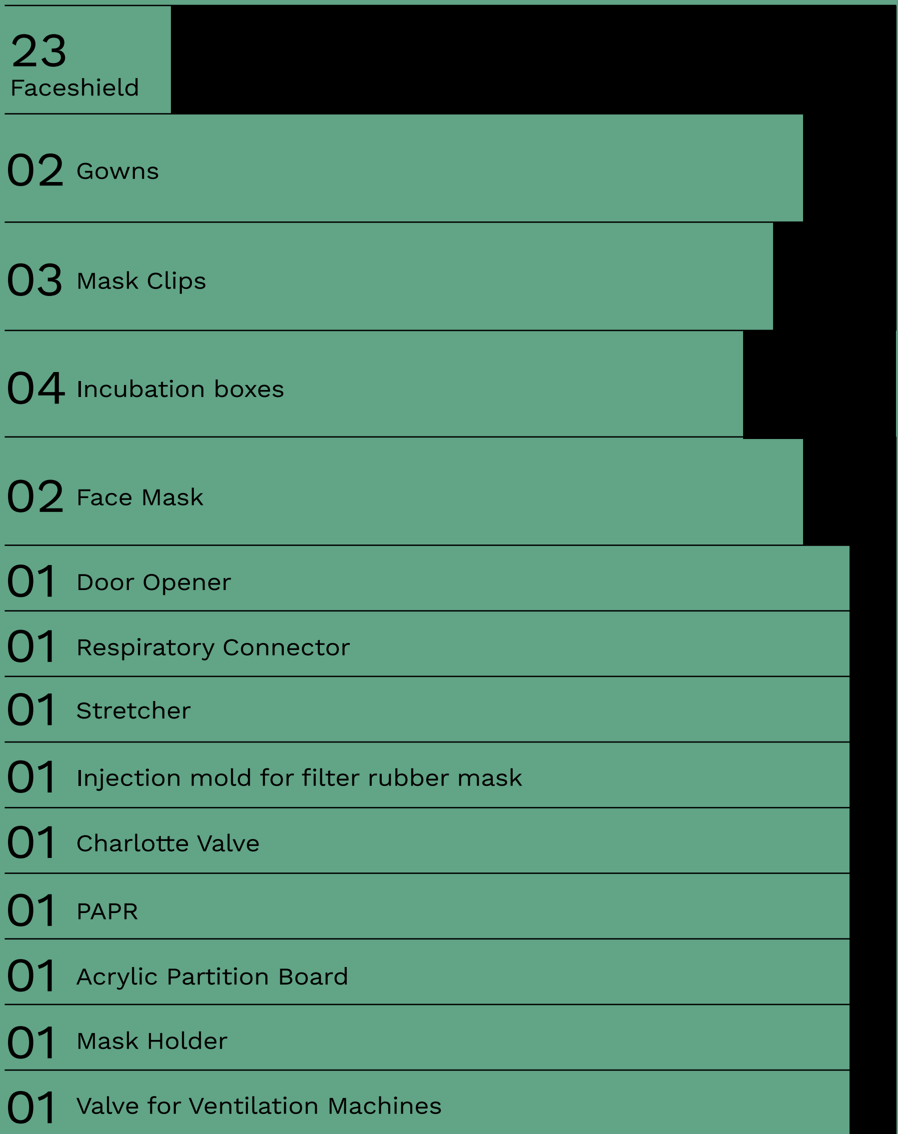
06 Respirators



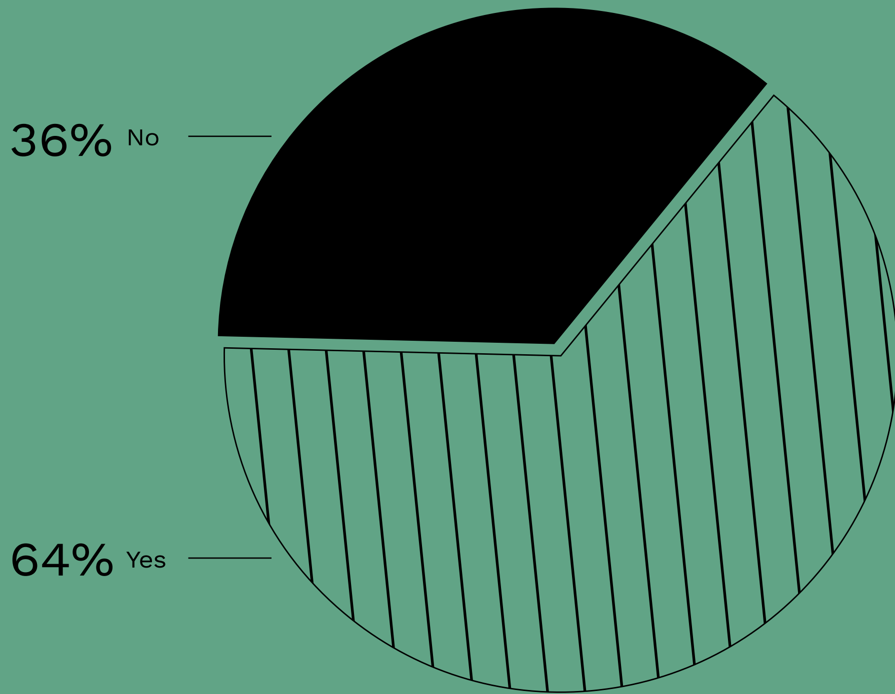
19 Other things: Ear savers, door stops and door handles, intubation boxes, PAPREar saves

Specific information about the PPE and medical supplies that are made

42 Products in total



Has your product been approved or medically reviewed by any agencies or organizations?



Of the yes, many selected multiple of the more specific examples:

22	Hospital
02	Local
06	National
15	Healthcare professional
06	Other, including one "Similar design and Fabrics beeing used by manufacturers approved by national certifying organisations"

Viral Design

Enrico Bassi from FabLab OpenDot

Introduction

The COVID-19 crisis has been compared to various other tragedies from the past, from the Spanish flu, due to its contagiousness, to a genuine war and the number of victims.

It certainly wasn't the first global threat, but, for the first time, we experienced a global response. Technological tools have helped us to be truly united in working out how to defend ourselves, how and what to design and build to protect ourselves and those taking care of us.

The response to the crisis was not just about 3D-printing and makers. What occurred was a first, unintended field trial of a new production model which integrates and completes the previous one. Developing a new solution requires a long series of steps to go from an intuition to a solution to be sold. This process is often centralised in the hands of the producer who outsources some activities, but who controls and invests in the solution. This model, which is highly interconnected and slow, failed in the face of the needs that suddenly emerged from the crisis. Unused to being interconnected, flexible, and distributed, producers were caught off-guard and proved ineffective in providing a solution. This can be seen and similar to an organism which is defenseless to a virus. Now, looking back, we can see how the response of Fab Labs, makers, and designers was effective precisely because it fought the pandemic with its own weapons.

What we can Learn from a Virus

Why not let ourselves be inspired by the very threat we fought? Can we understand what elements made the response of Fab Labs and makers so effective and what areas could we further improve on to be rapid in terms of disseminating useful solutions?

What emerges is a completely new perspective in terms of developing projects, from their conception to their final distribution. This perspective involves several protagonists at different points to enable them to best show off their skills.

We've called it Viral Design: an approach to generating solutions with rapid dissemination from a global to local scale.

So, what can we learn from the threat that we're facing?

Changing

Everything that lives changes. The faster something changes, the more versions there are of it, and the more likely it is that one of these will be effective. In a highly complex situation that is rapidly evolving, the development of many different ideas is not only natural but needs encouragement. The distributed development of different versions of solutions by small-scale communities offers an opportunity for enhanced design iterations through successive feedback loops. This "diverging" stage is just the beginning. Some versions will prove to be better adapted to peoples' needs, to production capacity, to the available budget, to the supply chain that is still active, to national certifications, and to available production technologies. Just like in a natural context these tend to be disseminated and to prevail.

When this happens we begin to concentrate on a few main strands that then become de facto standards. The features of these touchstone projects will gradually spread to others, slowly making them converge. Just as it's important to share and disseminate your own ideas in the beginning with decision and strength, it's just as important to come together with humility on others' solutions if these turn out to be more effective. This is only possible if ideas are shared online, if they're accessible and can be changed, remixed, and reproduced. These are all simple familiar concepts and tools within maker communities.

First Disseminated through Hyperconnected Places

Although infection between people occurs based on their proximity, spreading from place to place depends on how interconnected they are. If many people move quickly from one place to another, the risk of infection is higher - the virus has almost always crossed borders by plane. For this reason, responses to the pandemic were especially well disseminated within strongly connected communities, and, even more so, among laboratories with strong relationships.

Networks become one of the essential ingredients to spreading solutions. The more cohesive the networks are, the more effective they are; the more homogenous, the quicker they spread ideas and solutions. The Fab Lab network was a natural vehicle for this dissemination. The labs have similar equipment, a number of shared values, the habit of documenting and sharing, as well as skills in rendering a new idea concrete and replicating existing ones.

To facilitate further dissemination, we created network structures that were even more cohesive and homogenous, often in regions with the same language and similar legislative frameworks and needs. Fostering these networks constitutes an enormous step ahead in improving the efficacy of our responses.

Jumping between Different Species

Many of the most aggressive pandemics are spread by pathogens that normally attack other species. As a result, the new host is totally unprepared and the results can be very dangerous.

For a solution to have a real impact, it has to reach people. To reach them, it has to be disseminated. Although this can easily happen within a homogeneous network, often not enough people are reached. To be effective, each stage of the project must be able to develop in the most congenial species and then jump to another species in order to end up in a new host that would not have been able to create what the first one did.

Let's use an example to clarify: a doctor has an intuition, he or she discusses it with a maker (we use the term broadly, to include whoever uses technical skills to devise creative solutions). The maker transforms this intuition into a project, tests some pieces of it, and improves it with the help of its creator. The idea is a good one and a few dozen are needed, but the individual maker cannot produce them all and enlists the help of a local Fab Lab. The project evolves into a functioning prototype that is constantly improved by the small community working on it (including inventors, makers, and designers).

The idea is disseminated and changed: many versions of it are devised thanks to the contribution of other makers, Fab Labs, and doctors who use it. Some solutions are capable of jumping species again, providing an effective response to durability, user friendliness, size, sanitisation, production speed, material supply, and cost, etc. thus becoming standards.

The impact at this time is still limited because dissemination is slowed by the limited distribution network or the lack of certifications. The final jump is towards the manufacturing world, which usually deals with these issues. Jumping species is essential and must be encouraged, by breaking down and preventing all obstacles that get in the way.

Some examples of obstacles include: unclear business models regarding the distribution of benefits among partners, lack of interest in scaling projects, fear of losing ownership of an idea, etc.

Development Stages and Species Jumps

To summarise, a jump from one species to another is a jump to the ideal context for that specific project stage and to the person best able to carry it forward. At the same time, by analysing obstacles, we can understand the actions that we should take to improve systemic effectiveness.

- Intuition: it may occur to anyone, but it'll probably be linked to knowledge of the need.
- Figure: Need knower
- Number of items made: zero
- Design: the need arises, this is transformed into a concept and then into a proof of concept.

- Figure: Makers (broadly speaking, including developers, designers, makers, engineers, etc.)
- Number of items made: one to five
- Prototyping: the project is refined and the stages for implementing it defined (technologies, material supply, assembly, and shipping) through a series of progressive steps.
- Figure: Lab (Fab Lab, makerspace, hackerspace, business development lab, etc.)
- Number of items: 5,500
- Mutation (variation)
- Distributed production
- Matchmaking (demand and offer): the interaction between several labs generates a multitude of project variations (some substantial, others incremental) that are produced in a distributed way and reach whoever needs them and has contacts with the network.
- Figure: Network (specifically created, existing, etc.)
- Number of items made: 500— 1,000,000
- Industrial production
- Certification
- Distribution: the most effective ideas, which are already known to users and tested in the field, may go through the current testing, technical validation, and distribution processes that make it possible to reach whoever may need them.
- Figure: Local and international producers (SMEs, large companies)
- Number of items made: 1,000,000 +

Species jumps aren't always simple. An intuition can die because someone decides it's not worth talking about, or doesn't know who to talk to about it, just like a project can use the wrong licence that limits its dissemination. The final steps are, then, the most complicated. Here, the relationships between the community and corporate sectors are made difficult by mutual distrust, a lack of best practice, and appropriate business models, etc.

Understanding where the project breaks down helps not only to improve the individual process but also to improve the whole infrastructure.

What is Viral Design

Viral design, then, has a number of features that make it particularly effective in responding to quickly evolving situations, making the most of various actors who can contribute to achieving excellent results.

Features

- Viral Design changes: it generates many solutions from a single one, even if just to adapt to different local realities.
- Viral Design first diverges: one solution generates many so that their

effectiveness can be tested.
- Viral Design is disseminated: it has an alter ego made of bits and knowledge that is easily disseminated through networks and platforms
- Viral Design then converges: it concentrates production effort on the most effective solutions, selecting de facto standards.
- Viral Design is open: everyone must be able to use it freely - or under easy, inclusive, and clear conditions - in order to enable the development of its other features
- Viral Design is collaborative: each stage has an actor who can undertake that stage better than others; the project must change hands many times to provide a faster and more effective response.
- Viral Design is collective: everyone has a role; without others it would not reach a conclusion or it would not reach that point. It is difficult to identify an author, but it's not anonymous. It is the result of a team that has to divide the efforts and benefits that the project brings.

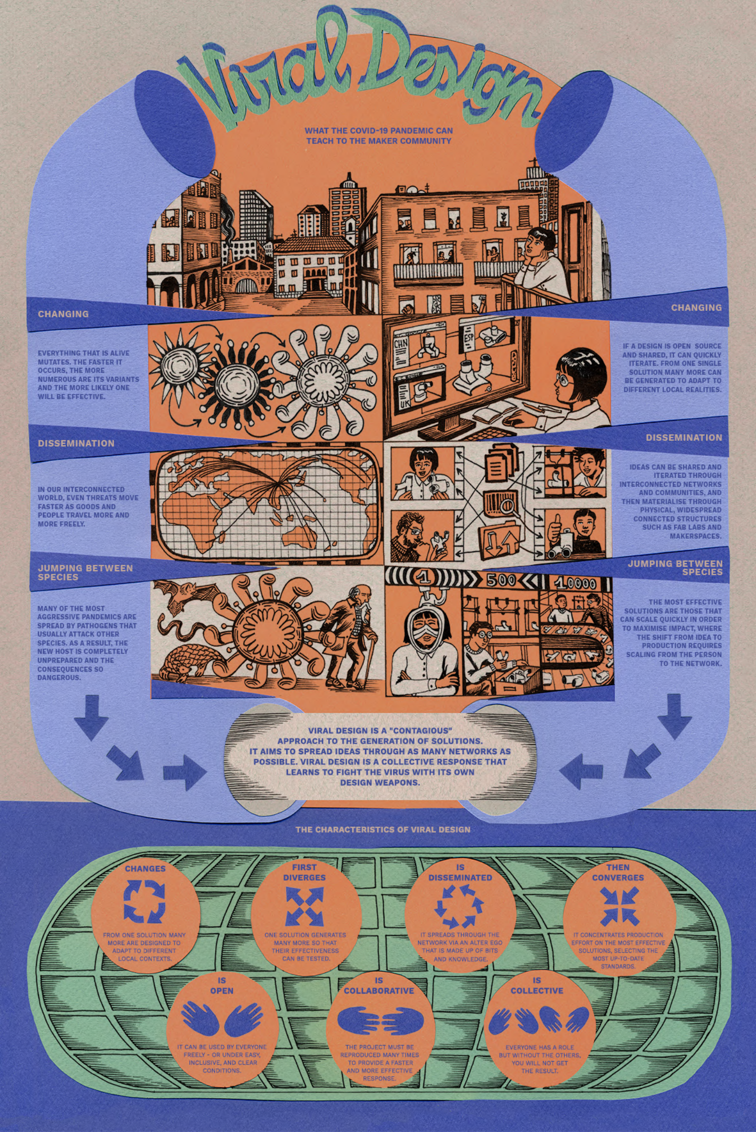
Where to from here?

Viral Design emerged as a natural response to the pandemic because COVID-19 catapulted us all into a situation we'd never experienced with this intensity: difficulties in product distribution, in centralised production in large clusters, and in the fast development of solutions to unprecedented problems, etc.

This doesn't mean that it's the only case where Viral Design can be applied. All situations that occur on a global scale that are not met with effective responses in the industrial production system could be approached from the way we have seen distributed mobilisation in the COVID-19 crisis. Global threats such as climate change, or widespread and ubiquitous issues such as accessibility share features with the crisis we're experiencing. They are just not as visible, homogeneous, or rapidly evolving. They could, however, be the next testing ground for a synchronised international response from a global network.

The closing article, "Viral Design" offers a premise of how we could apply learnings from the approaches taken during the COVID-19 crisis. We are facing a stark reality that this crisis will not be the only thing we have to mobilise and rapidly design for. If we analyse the response from the past six months, we can see the effectiveness of a collective design response which worked distributedly across the world - from the local to the global. This may be our most powerful strategy for tackling the next pandemic to come.

Illustration by Cecilia Valagussa


Viral Design
WHAT THE COVID-19 PANDEMIC CAN TEACH TO THE MAKER COMMUNITY
CHANGING
EVERYTHING THAT IS ALIVE MUTATES. THE FASTER IT OCCURS, THE MORE NUMEROUS ARE ITS VARIANTS AND THE MORE LIKELY ONE WILL BE EFFECTIVE.
CHN
ESP
UK
CHANGING
IF A DESIGN IS OPEN SOURCE AND SHARED, IT CAN QUICKLY ITERATE. FROM ONE SINGLE SOLUTION MANY MORE CAN BE GENERATED TO ADAPT TO DIFFERENT LOCAL REALITIES.
DISSEMINATION
IN OUR INTERCONNECTED WORLD, EVEN THREATS MOVE FASTER AS GOODS AND PEOPLE TRAVEL MORE AND MORE FREELY.
DISSEMINATION
IDEAS CAN BE SHARED AND ITERATED THROUGH INTERCONNECTED NETWORKS AND COMMUNITIES, AND THEN MATERIALISE THROUGH PHYSICAL, WIDESPREAD CONNECTED STRUCTURES SUCH AS FAB LABS AND MAKERSPACES.
JUMPING BETWEEN SPECIES
MANY OF THE MOST AGGRESSIVE PANDEMICS ARE SPREAD BY PATHOGENS THAT USUALLY ATTACK OTHER SPECIES. AS A RESULT, THE NEW HOST IS COMPLETELY UNPREPARED AND THE CONSEQUENCES SO DANGEROUS.
1
500
10000
JUMPING BETWEEN SPECIES
THE MOST EFFECTIVE SOLUTIONS ARE THOSE THAT CAN SCALE QUICKLY IN ORDER TO MAXIMISE IMPACT, WHERE THE SHIFT FROM IDEA TO PRODUCTION REQUIRES SCALING FROM THE PERSON TO THE NETWORK.
VIRAL DESIGN IS A "CONTAGIOUS" APPROACH TO THE GENERATION OF SOLUTIONS. IT AIMS TO SPREAD IDEAS THROUGH AS MANY NETWORKS AS POSSIBLE. VIRAL DESIGN IS A COLLECTIVE RESPONSE THAT LEARNS TO FIGHT THE VIRUS WITH ITS OWN DESIGN WEAPONS.
THE CHARACTERISTICS OF VIRAL DESIGN
CHANGES
FROM ONE SOLUTION MANY MORE ARE DESIGNED TO ADAPT TO DIFFERENT LOCAL CONTEXTS.
FIRST DIVERGES
ONE SOLUTION GENERATES MANY MORE SO THAT THEIR EFFECTIVENESS CAN BE TESTED.
IS DISSEMINATED
IT SPREADS THROUGH THE NETWORK VIA AN ALTER EGO THAT IS MADE UP OF BITS AND KNOWLEDGE.
THEN CONVERGES
IT CONCENTRATES PRODUCTION EFFORT ON THE MOST EFFECTIVE SOLUTIONS, SELECTING THE MOST UP-TO-DATE STANDARDS.
IS OPEN
IT CAN BE USED BY EVERYONE FREELY - OR UNDER EASY, INCLUSIVE, AND CLEAR CONDITIONS.
IS COLLABORATIVE
THE PROJECT MUST BE REPRODUCED MANY TIMES TO PROVIDE A FASTER AND MORE EFFECTIVE RESPONSE.
IS COLLECTIVE
EVERYONE HAS A ROLE BUT WITHOUT THE OTHERS, YOU WILL NOT GET THE RESULT.

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N/A

Supply chains and Materials

The Role of Local Materials in Building Resilience

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Covid as a Catalysist

N/A

No Arduino? No Problem!

N/A

Modularity and the Commons as Conditions for a Resilient and Sustainable Society

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[20] This article is a rework of an article published in Halduskultuur. Available at: http://halduskultuur.eu/journal/index.php/HKAC/article/view/228

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Organising, Deployment and Distribution

Happylab: Makers Against COVID-19

N/A

Spanish Makers' Ongoing Fight Against COVID-19

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Life and Times of COVID-19

Hyper Domestic X Hyper Global

N/A

FABSCHOOLS - Maker Education From Home

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[21] "Open Educational Resources are teaching, learning and research materials in any medium – digital or otherwise – that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions "
[22] Find the deck and interviews in our resources page at fabschools.pt
[23] https://wikifactory.com/
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Fab City and Cosmolocalism (Be)for(e) COVID-19

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[25] COSMOLOCALISM is a research project and has received funding from the European Research Council under the European Union's Horizon 2020 research and innovation programme (grant agreement No 802512).

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STYKKA— Designing for the Unknown

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Closing

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Viral Design

N/A

Co-editor
Kate Armstrong, Distributed Design Project Lead, Fab Lab Barcelona at IAAC

Co-editor
Paula Sánchez Toribio, Distributed Design Global Activities Manager,
Fab Lab Barcelona at IAAC

Co-editor
Emily Whyman, Distributed Design Content Curator and Writer,
Fab Lab Barcelona at IAAC

Graphic and Editorial Design
Manuela Reyes, Art Director, Fab Lab Barcelona at IAAC

Art Work Advisor
Marcel Rodriguez, Creative Strategist, Fab Lab Barcelona at IAAC

Content Advisor
Tomas Diez, Director, Fab Lab Barcelona at IAAC

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The year of 2020 will be unforgettable in many ways. It in some ways symbolises a year of contradictions - we have experienced mass mobilisation to generate collective intelligence, yet we have never been so geographically and physically restricted. The Coronavirus (COVID-19) pandemic has affected all areas of society, from supply chains to education. One of the key things we have experienced during this unprecedented period, is the rapid uptake of distributed design. The collaboration of makers and designers to collectively prototype, produce and distribute has mitigated negative impacts of halted supply chains, opened up intellectual property rights (IP), formed new partnerships between businesses, designers, key workers and most importantly, set the foundation to question the resilience of newly forged networks for the future.

This book collects observations and reflections from the Distributed Design Platform and extended community. It offers a selection of different articles, profiles and case studies of designers and makers across Europe and the rest of the world during the COVID-19 pandemic. Most importantly, it highlights and explores the socio-technological role and cultural impact of distributed design in the response to crisis.

Distributed Design

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