

# Design during COVID-19: agents and allies in the role of designer, digital fabrication and distributed production.

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## ABSTRACT

During COVID-19 global emergency, designers proposed solutions at different scales, as quick responses to demands from different agents. In the same way, we critically analyzed the emergence of allies, protocols and tools, which allowed the optimization of fabrication, from traditional manufacturing into distributed co-production. The analyzed local networks produced global co-design experiences, with involvement of FabLabs and users from different disciplines. Through case studies and the evaluation of surveys and testimonials from users and makers, we analyze the global panorama, to finally explore the specific situation in Latin America. This establishes a relationship between medical demand and digital fabrication, which allows evidence of positive and negative situations to be considered as new, significant aspects for the design in the future. The leading role acquired by the ecosystem surrounding digital fabrication during the pandemic, could enhance its processes in the search for greater positioning, changing society from within the different communities.

*Keywords: distributive design, FabLabs, geographical mapping, Latin America.*

## 1. MAPPING THE ROLE OF DESIGN BEFORE AND DURING COVID-19 GLOBAL EMERGENCY

The discipline of design studies is especially important in the context of the pandemic because it allows us to recognize, within a broad scenario of initiatives, the affirmation of trends, advantages and limitations of the role of digital fabrication as an ally in solving design problems.

One of the highlights in dramatic historical moments such as wars, natural disasters or epidemics is that its victims can be found in all contexts. The designer and the architect are not working for third parties, but for themselves, and they fall into this atypical situation of being both designers and possible future users. A notable example in the first half of the 20th century is the case of Aalto, who was ill and in bed during the design of the unbuilt project of the tuberculosis sanatorium in Kinkormaa (Colomina, 2019, p.65), forerunner of the Paimio sanatorium (1928-1933). Being a real or potential victim of circumstances, and having to come up with first-person design solutions, places the designer in a strange moment of empathy from which few contemporary architects can boast. Since 2020, COVID-19, has put us in a similar situation, where we, designers, architects, urban planners, fabbers and makers, have become clients, generating empathy with the world in a situation that affects us all.

## 2. THE SCALE OF DESIGN AND ROLES

In the first months of the COVID pandemic, we found differences in the application and results of design on different scales: from objects to buildings. A direct parallel cannot be established, since architecture has slower processes and is dependent on much more complex production and economic processes, and therefore lacks the speed needed for immediate response. Unlike the design of objects during the emergence of COVID-19, the abundance of theoretical architectural proposals was only materialized in the installation of temporary health centers, adaptation of existing buildings for other purposes, and the use of technologies for the simulation and analysis that social distancing imposed.

The requirements for health and fabrication system specialists reached all scales of design. Design patterns for non-specialists became more specific as the contagion behavior of COVID-19 was better understood. The medical devices generated parameters and the political, economic and health regulatory requirements defined the constraints. That combination redefined the designer's role in this emergency. Neumann (2008, para. 10) argues that the “roles are defined by specific attributes, behavior and social relations” that a society demands and determines, in terms of obligations and expectations through its norms. In this research, we explore how digital fabrication laboratories became the ecosystem that allowed us to meet the demands of the health system, the government, society, and designers. This, in addition, occurred thanks to open source design environments and communications platforms that promoted the prosumer over the consumer, within a distributed chain of actions, which encouraged designs through open design.

### 2.1. Designer role

For the design of medical devices, the designer's role has been completely different from pre COVID-19 experiences. Privitera (2017), studied situations where industrial design meets the highly regulated health sector, identifying that this industry requires multidisciplinary collaboration between researchers and physicians, access to a repository of information, regarding the progress of the development medical devices, finding that “it was impossible for a single person to be a an expert in the clinical, technical, and scientific domains relevant (...) for the purposes of developing a medical device” (Privitera, 2017, p. S2191). Privitera identified the solutions were mainly limited to three aspects: (a) Aesthetic design, (b) Human Factors and (c) Branding. Some additional challenges were identified in the process: Value, Limited application and Specialization. Design in emergencies does not take any of these later aspects or challenges, because the spreading time imposes using the products while they are being fabricated.

### 2.2. Makers role

For designers with links to FabLabs and Makerspaces, the context of the COVID-19 was also a new circumstance, just like it was to industrial designers and architects. Not only required unprecedented health equipment, demanding designers' proposals from the scale of objects, products and services to architecture and urban planning. The situation added other challenges to the process, with new roles such as those proposed by Hasselblad (2020) of Artisan's Asylum, Inc.: (a) Coordination costs (b) Material availability and (c) Uncertain demand, typical of the speed of contagion of this pandemic. Added to this, the first demand in this emergency came from the health systems, which entrusted to designers and makers, the

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responsibility of manufacturing and ensuring the safety of medical devices (Azman et al. 2017) -a role that under normal circumstances it is delegated to other teams- making them challenges that have overcome the willingness to just design and fabricate in this emergency.

Among these additional requirements to the designer's role in this emergency, there is the need of thinking about four challenges: (a) products regulated and safe for patients and medical personnel, as argued by Ferracane (2020) from the "European Center for International Political Economy". (b) Solving disinfection, reuse of manufactured products, as well as waste management, as stated by Garmulewicz (2020) of Universidad de Chile (as cited in Singh, Tang & Ogunseitán, 2020 and You, Sonne & Ok, 2020); (c) Distribution of products when infections are very advanced, as Díaz (2020) of the FabLab Bilbao maintained. (d) tracking product performance over time and finally (e) preventing starting from scratch again, as argued by Garcia (2020), co-founder of Makerspace Madrid and Corona Makers Forum in Spain.

This context clarifies the differences between the role of designers and makers before COVID-19 and their role as also clients and users in this health emergency. We believe that not only are objects important in defining the designer's role, but we need to explain the culture behind them, who demanded them and who promoted them, as Mumford argued (1998, p.22). In this research, we make a preliminary exploration of design studies of good practices around the world, with special emphasis in analyzing Latin America initiatives between March and July 2020.

### 3. ORIGIN OF NEEDS IN PANDEMICS AND COVID-19

Eleven years ago, between January 2009 and August 2010, there were 18,449 deaths in 214 countries due to the 2009-H1N1 (WHO, 2010) or Swine Flu Pandemic. Almost a decade later, between December 2019 and April 2020, COVID-19 reached 209 countries, with 1'604,982 infected individuals and 95,693 deaths (WHO, 2020a), far exceeding the numbers of the previous pandemic.

On July 23, 2020, the confirmed total reached 15,445,043 with a global death of 632,173. In April the IHME (2020) projected that in August 2020 only the US would reach 60,415 deaths, but as of July 23, there were 144,242 deaths, even though the number of affected countries decreased to 188 (JHU, 2020).

Despite the promotion of public health policies, the percentage of cases and deaths created a greater need for health system services (Ferguson et al., 2020), increasing the demand for medical products. Without a vaccine, the only way to minimize transmission and spread has been non-pharmaceutical interventions (NPIs). This includes four main measures and topics (a) Personal protective measures: Hand hygiene, respiratory etiquette, face masks. (b) Environmental measures: Surface and object cleaning, other environmental measures (UV light, ventilation and humidity). (c) Social distancing measures: Contact tracing, isolations and quarantine of exposed individuals (Household, Home and Self), School closures (Class dismissal, Reactive Closure, Proactive Closure), Workplace closures, Workplace measures, Avoiding crowding. (d) Travel-related measures: Travel advice, Entry and exit screening, Internal travel restrictions, Border closures. (WHO, 2019).

Non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand serve as parameters and restrictions to identify design needs for the population, in a

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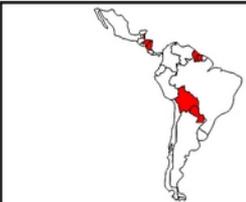
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scenario that is not limited to the local but has the same conditions in the entire world. The role of design considered these measures as the basis for the proposals and solutions. For a designer, products usually respond to the understanding of the needs of a client (an individual or a society), but pandemics make the designer their own client, living in the same scenario, which gives them the possibility of being more empathetic with solutions for their own life and that of those around them.

In this context, since March 2020, the digital fabrication laboratories in the world have become the best allies of designers in their role in the face of this emergency. They became hubs of their own network where “all design is co-design”, a phrase by Manzini (2014, p.99) who maintains that “in a highly connected society designing actors cannot escape from interacting and influencing each other”.

#### 4. METHODOLOGY

To examine agents and allies in the Latin American community of designers and makers, we draw on three main sources, to analyze countries with infrastructure and experience in digital fabrication. In the last 9 years, We, the authors have mapped initiatives of digital fabrication laboratories in Latin America (Herrera & Juarez, 2013; Sperling et al., 2015; Sperling & Herrera, 2015, Scheeren et al., 2018), monitoring 52 fabrication laboratories included in Homo Faber (Latin America Exhibition), created mostly in universities prior to the FabFoundation initiatives. The second source, from industry and government, was through the Latin America Fab Lab Network (FABLAT). Between March 24 and June 29, 2020, the Peru-based FABLAT organized 15 “FabTalks” including 73 FabLabs presentations from Spain and 16 Latin American countries. From these networks of contacts, we analyzed regional and global initiatives that, between March and July, responded with design-based proposals against COVID-19 (Network in Figure 1).



		South America										North & Central America									
		Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	Guyana	Paraguay	Perú	Surinam	Uruguay	Venezuela	Belize	Costa Rica	El Salvador	Guatemala	Honduras	México	Nicaragua	Panamá
Network	FabLab Network	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Homo Faber exhibitions	●		●	●	●			●		●				●	●			●		●
	FABLAT FabTalks	●		●	●	●	●			●			●		●	●	●		●		●
Awards	International Design Award																				
	Santander X	●		●	●				●										●		
	Global Grad Show 2020	●							●										●		
Surveys	Design for Emergency			●			●		●												
	PsyCorona	●		●	●				●										●		
	CESUGA	●		●	●	●	●		●										●		
	NOMADS	●		●	●	●	●		●		●								●		
Open Source Environment			●	●				●													
Activities per country		8	1	9	8	5	5	0	1	10	1	3	2	0	3	3	2	0	8	0	2

Figure 1. Selection criteria.

Prize systems represent different motivations and objectives (David & Davis, 2004, p.23), but the global emergency was transversal to all these intentions. We studied the participation of these countries in innovation and design awards competitions linked to COVID-19 proposals

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(Awards in Figure 1), considering the study by Makkonen & Inkinen (2014), who argue that this is an indicator of the quality of innovation and produces a positive and significant effect on the future of the participants, increasing credibility even though the motivation is not monetary.

Herrera et al. (2020) found that in the online content only 5% of the proposals that identify architectural transformations in the context of COVID-19 were from Latin America. With the same intention, and as a third data source external to FabLabs, but on the scale of the product and the object, we looked for calls and patterns of activities against COVID-19 registered between March and July 2020 by the main global design institutions linked to graphic design, industrial design, and architecture: World Design Organization, DESIS Network, Design Research Society, Cumulus Association, Industrial Designers Society of America, American Institute of Architects and the International Council of Design.

Finally, we analyzed the countries that participated in four global and regional surveys (Surveys in Figure 1) from academia, as an indicator that promotes future solutions if we understand the situation of confinement from the design.

#### **4.1. Selection criteria and limitations**

From north to south, Latin America is conformed by 20 countries. We did not consider seven countries (countries in red, see Figure 1): four of them (Guyana, Belize, Honduras and Nicaragua) do not have FabLabs registered with FabFoundation, and Bolivia, Paraguay, and Suriname, although registered by FabFoundation, did not registered any activity common to the analyzed countries (see activities per country in Figure 1).

Thus, our critical analysis included initiatives from 13 countries (65% of the total number of Latin American countries) that evidenced at least two selection criteria (see activities per country in Figure 1), which allowed us to classify agents and allies and define the groups that make up this preliminary research. We refer that Paraguay registered activity during COVID-19 through “Makers for Paraguay” (<https://makers.com.py/>), which together with Suriname and Bolivia will be part of a future research.

### **5. AGENTS PROMOTING THE DESIGNER’S ROLE IN THE FACE OF THE COVID-19 EMERGENCY**

In the critical analysis of these laboratories, we identified that industry, government, associations, design institutions, and academy partners brought together initiatives in different categories, strengthened by their own interests to understand the future of this emergency. (Figure 2)

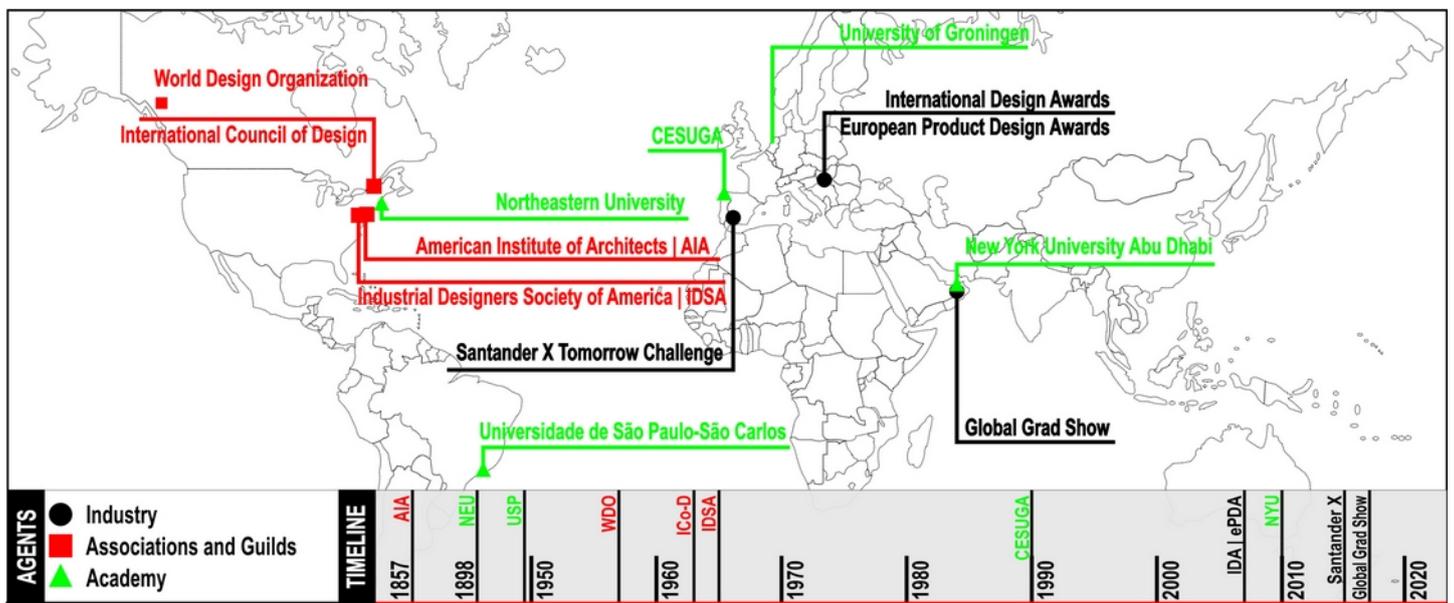


Figure 2. Timeline/year of foundation and geographic location of agents and allies.

## 5.1. Industry

At this point, the results were not significant, considering that many of the 46 International Design or Innovation Awards (Boost Awards, 2020) were postponed, canceled or maintained the same objectives of previous years and not linked to the emergency of COVID-19. An exception was the Farmani Group, organizing the “COVID-19 Design Innovation Grant” for the International Design Awards (IDA) and the European Product Design Awards (ePDA) (IDA, 2020), but without a Latin American presence in its results. The following two cases tried to compensate, with the “Santander X Tomorrow Challenge” of Banco Santander (Spain) aiming for Latin American presence oriented to service responses to COVID-19, and the “COVID-19 initiative: Finding solutions to collateral issues of the pandemic” of the Global Grad Show 2020 (Dubai), which had as one of the winners Mexico, and 10 finalists from Mexico, Peru and Argentina. We do not consider the MIT Challenge Latin America vs. COVID-19 (MIT, 2020) because the teams were multinational, with only 8% of the competitors living in Latin America, which made it difficult to identify a possible impact in the country of origin.

## 5.2. Associations

We selected the largest and oldest associations of graphic design, industrial design, and architecture, which adopted an empathetic position with the emergency, promoting the role of the designer in each of the specialties of the respective groups.

The International Council of Design, “believes that the future will, and must be, different” based on a pending agenda of necessary changes in the roles and responsibilities of designers, redefining the designer/producer/user relationship. ico-D considers that this disruption and crisis that we are experiencing is an opportunity that reinforces the need for change in the profession and education towards a new normality (ico-D, 2020).

From Montreal, Canada, the World Design Organization (WDO), formerly known as the International Council of Societies of Industrial Design (ICSID) also maintained that “in times of crisis, design enables collective action to make the greatest impact” (WDO, 2020). Together with IBM and Design for America they made the worldwide call for solutions: “COVID-19 Design Challenge” with the question “What do you think are the most important

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and urgent challenges that designers could help to address regarding the coronavirus crisis?”. It is a 5-category initiative where designers could make a difference in this emergency: (a) Awareness & Communications (b) Essential Workers (c) Vulnerable Communities (d) Remote Learning (e) Healthy Habits.

The Industrial Designers Society of America (IDSA) presented the 2019 IDSA Personal Recognition Award to Dan Harden. He was asked in the context of COVID-19 and the future of industrial design “How will this pessimistic start to the decade affect the industrial design profession, and what does the coming decade have in store for the business of design and its subject matter?” (Harden, 2020), He responded: “This is where designers come in because crafting positive change to better life is what we do. Our immediate future mission because of the pandemic will be to solve design problems around protection, place and process.”

The American Institute of Architects promoted five initiatives to confront COVID-19: (a) Reopening America: Strategies for safer building (b) Risk Management Plan for Buildings worksheet (c) AIA Re-occupancy Assessment Tool (d) Design for adaptability , deconstruction, reuse (e) Alternative Care Sites Preparedness tools.

### 5.3. Academy

With a global and common problem, since March 2020 unprecedented surveys were launched from universities around the world to learn from problems in isolation (see Figure 3).

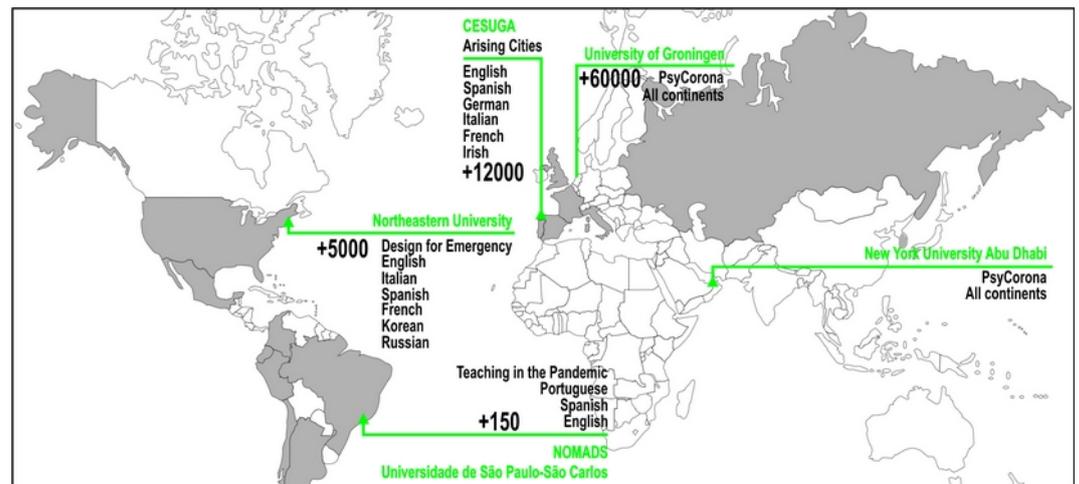


Figure 3. Architectural and Psychological Surveys around the world during COVID-19

In the United States, “Design for Emergency” (<https://designforemergency.org/>) (Colombo & Ciuccarelli, 2020) of the Design Center of Northeastern University, has promoted a survey in 11 countries, and an open platform for analyzing the results to face COVID-19 through design. In Latin America, this initiative is led by universities in Brazil, Ecuador, Mexico, and Peru. Between March 19 and May 25, the “PsyCorona” (<https://psycorona.org/>) multi-country study of the University of Groningen (Netherlands) and NYU Abu Dhabi, identified the psychological impact of COVID-19, which for the field of design promotes opportunities to understand issues during confinement. Of the 29 countries included in the study, four are from Latin America (Argentina, Brazil, Chile and Peru). In April, from Spain, the Escuela-Arquitectura-CESUGA (<https://cesuga.com/ciudades-emergentes/>) led the survey “Inhabiting post-pandemic cities” with 16 universities in 12 countries including Ecuador,

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Mexico, Brazil, Chile, Colombia, Argentina, and Peru, which received more than 12,000 responses.

In education, the “Center for Interactive Living Studies” (NOMADS) of the University of São Paulo (USP), Brazil (Tramontano et al., 2020), conducted a survey between June 24 and August 10, 2020, with 166 respondents (Brazil: 124, Latin American countries: 34, other regions: 8) to the project “Remote teaching of architecture in a time of pandemic”. 14 countries joined, including eight in Latin America (Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru and Uruguay) with results that allow to identify remote teaching modes in architecture, urbanism, and landscape design during COVID-19.

## **6. ALLIES PROMOTING THE ROLE OF THE DESIGNER IN THE FACE OF THE COVID-19 EMERGENCY**

### **6.1. Open source design environments**

Before COVID-19, a lesson learned from 2009-H1N1 was the need for new tools for risk and outbreak communication (Abraham, 2011). Troxler (2010) proposed Fab Labs as a business model if they provide infrastructure and innovation. In the context of COVID-19, collaboration between fabrication laboratories through open design environments demonstrates the network response capacity to strengthen the de-centralized manufacturing chain between those who need help and those who provide it, integrating producers, suppliers, applicants, investors, and donors to achieve a common goal.

For this reason, this section draws a parallel between the evolution of COVID-19 and the initiatives that allowed designers around the world to join work ecosystems for local production from a global perspective. The cases reported in this section are of a global or regional reach, promoting networks to contribute, connect, and learn through ad hoc created platforms for open design. These open design environments have surpassed the borders of their centralized operations headquarters in United States (Fab Foundation Network), Brazil (Co-Lab and Protegebr), Peru (FABLAT) and United Kingdom (Wikifactory). (See Figure 4.)

During the third week of February, China reported 77,000 cases of COVID-19 and Italy 76. In the third week of March, Italy reported 35,700 cases, Spain 17,361 and the United States 7,000. In those weeks, the Latin American middle class returned from vacations from the northern hemisphere, going back to their jobs, classes, and their daily routine. This is the reason why the first cases did not come from the peripheries, but from the residential and exclusive areas with access to private clinics, unlike the most vulnerable areas that are the largest population in Latin America, allowing for some preparation in the health system, for the more vulnerable population.

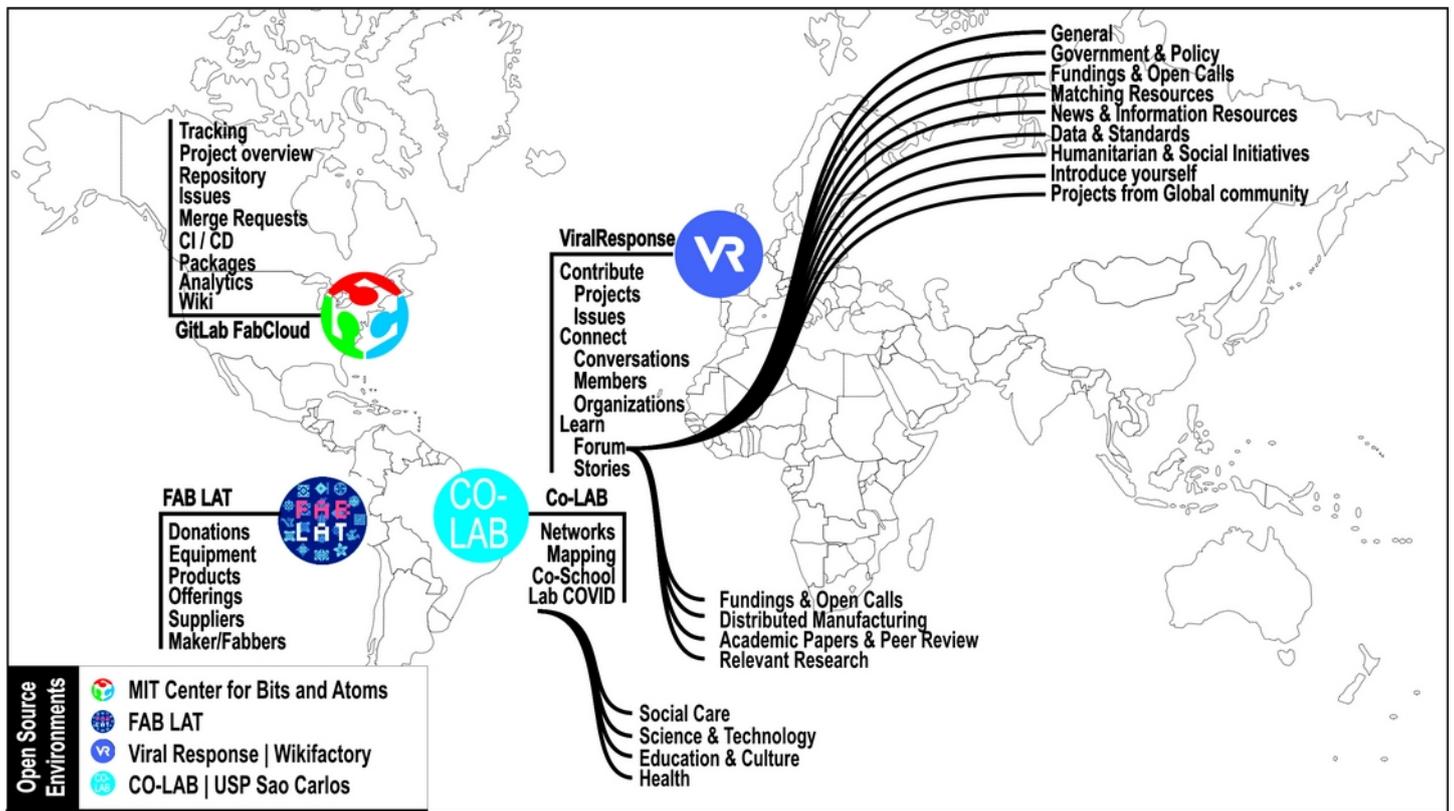


Figure 4. Open design environments.

COVID-19 arrived in Latin America and the first cases appeared between February 27 and March 13. Governments declared mandatory national confinement and the closure of their borders between March 15-24. Since then, initiatives were born from universities, which is where emerging technologies are promoted (Sperling et al, 2020). But unlike the Northern Hemisphere, Latin American universities were on their summer vacations, preparing to welcome 2020 students in March, therefore the closing and the difficulties for accessing fabrication labs was a problem. Days before confinement, some labs authorized the exceptional taking out of 3D printers to the coordinators' homes, but the access to equipment such as laser printers and larger CNC machines stationed at universities was almost impossible.

On March 17, 2020 Gershenfeld (2020) shared five communications to the Fab Foundation network about the Coronavirus Tracking project for Fab Lab Network development and deployment. On March 23, Gershenfeld (CBA, 2020) and a team of 30 people published a video that explains the actions to communicate and discuss the challenges and initiatives for design solutions to COVID-19.

Located in London, Wikifactory (<https://wikifactory.com/>), founded in 2018 by Tom Salfield, Christina Rebel, Maximilian Kampik and Nicolai Peitersen, is a social platform that enables teams to collaborate, design, prototype, and fabricate in an online workspace. In the context of COVID-19, they created the "Viral Response" platform (<https://viralresponse.io/>) dedicated to open design and hardware innovation that empowers local communities from a global infrastructure was included.

At the initiative of Alfredo Andía from Florida International University, on March 30, designers and architects from Universidad de Chile, Universidad de Temuco, Universidad Peruana de Ciencias Aplicadas, Pontificia Universidad Católica del Perú and Colegio de Arquitectos de Chile gathered to exchange ideas on the COVID-19 situation. In the last week

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of March, Latin America had not yet established their own open design environment to deal with COVID-19.

On March 31, China ranked fourth worldwide with 82,240 cases. The first place was held by the United States with 164,603, followed by Italy with 101,739 and Spain with 87,956. That day, FABLAT (2020a) based in Peru, carried out the Fab Talk "Community Makers / Fabbers of Spain against COVID-19" with guests such as Rebel (Wikifactory), to understand the actions to consider as COVID-19 arrived in Latin America. In May, the C-19 FABLAT platform (<https://login.aplicacionespymes.com/m/r5448/>) was launched in Peru. In this platform, products, requests for donations and deliveries, suppliers, manufacturers, makers and fabbers are registered, in an initiative that placed Peru as the headquarters of the network.

The convening capacity of these institutions and their connection platforms were important factors to cross the local border to connect government, industry, professionals, and academia. This did not happen with other initiatives, whose success was mostly local, by grouping together a limited number of fabrication laboratories, such as Redmakers-Fab (<https://redmakersfab.wixsite.com/website/>) in Chile.

In April, in Brazil, the Seção Técnica de Informática of the Instituto de Arquitetura de Urbanismo of the University of São Paulo based in São Carlos, created CO-LAB (<https://www.iau.usp.br/colab/>). It is an open platform of science and citizen participation, which develops projects with the aim of making demands visible during the emergency, connecting citizens and institutions, and promoting cooperation actions between them. In Rio de Janeiro, FabLab Olabi led by Gabriela Agustini sponsored the "Rede de apoio aos profissionais de saúde against COVID-19" (<https://protegebr.org/>). They identified 250 FabLabs initiatives that donated 950,021 face-shields in its country (FABLAT, 2020b).

## 6.2. Distributed fabrication against COVID19.

Due to its scale, the traditional industry supply chain does not have a coordinated scope. The solutions produced go through slow testing and prototyping processes, unsuitable for an emergency. Thus, the distribution processes that arise from local initiatives such as fabrication laboratories, use their small scale as an asset.

To this is added the close relationship with consumers (Kohtala, 2015), which gives off constant feedback that allows product improvements in a short time. "The customer is integrated into value creation during the course of configuration, product specification and co-design." (Piller et al., 2004, p.435) This will allow increasing efficiency and optimizing costs and eventually returning to the traditional supply chain, once the prototype has already been put into operation, in order to benefit from low-cost production and distribution (Figure 5A).

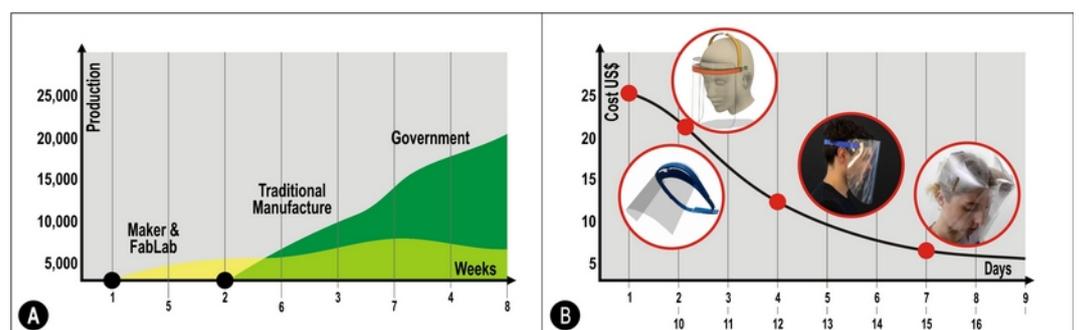


Figure 5. The contributed production in action.

Since March, volunteer designers around the world started distributed actions, delivering hundreds and then thousands of free masks, valves, connectors and protectors produced in makerspaces and FabLab communities, in an ecosystem that includes networks of manufacturers, material suppliers, open repositories, product follow-up and monitoring. This made possible the financing of massive distribution and low-cost designs for their countries. These actions will have an unprecedented impact on the way of researching, designing, and innovating, because they rapidly united society, government and industry in the context of transformative and democratic design and open knowledge.

In the context of COVID-19, Rebel (FABLAT, 2020b), argued that distributed communities prevailed because private fabrication production did not have the speed to respond to this emergency. Wikifactory was available for this emergency, not only to collaborate with the distribution of the models, but so that anyone with access to open designs, including peer reviewers and specialists, could validate or observe products.

### 6.3. Protected design and open design

The designer's role in this health emergency has been divided into two groups: those who proposed a protected design and the promoters of open design. In the context of the emergency, this second group has become more predominant, and the vast majority of identified initiatives promote collaborative design and open source solutions.

The World Intellectual Property Organization added to its PATENTSCOPE search tool the “COVID-19 Index” that uses Artificial Intelligence (AI) technologies to obtain high precision results (WIPO, 2020) to improve the detection, prevention, and treatment of diseases such as the novel coronavirus with patents distributed in 10 categories. However, the distributed design and open source environments noted in this research show that industrial protection was not an immediate priority for maker communities. In July, the Fab Foundation and Wikifactory teamed up through the Fablabs.io platform (<https://projects.fablabs.io/>), with a collection of online open resources for the international FabLab community to advance their initiatives.

Between January and July 2020, Peru reported that 1,514 inventors applied for 833 patents, 38% corresponding to inventions developed and aimed at combating the causes and effects of the pandemic. In June, Peru, through INDECOPI, has been the only country in its region to promote protected design with the “Special Patent Contest against COVID-19” initiative that received 313 applications and awarded 45 inventions (INDECOPI, 2020). However, the FabLabs initiatives in Peru were different, democratizing their designs and seeking cooperative solutions. By August 2020, they had donated around 40,000 face-shields nationwide.

The case of medicines is different. In this global and international emergency, Brazil promotes a law that considers them as goods of global collective interest and not as a commercial product. Costa Rica together with WHO promote the initiative “COVID-19 Technology Access Pool (C-TAP)” with 34 other countries (12 of them from Latin America) so that “Vaccines, tests, diagnostics, treatments and other key tools in the coronavirus response must be made universally available as global public goods.” (WHO, 2020b).

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## 7. DISCUSSION

The important production of digital fabrication in Latin America has already been categorized and grouped (Sperling et al., 2020, p.83), but the scientific publication of its practice is a pending task for the laboratory network. Documentation during COVID-19 has different perspectives, but through this research we approached its process using transversal indicators to 13 Latin American countries.

Menichinelli et al. (2020, p.3) explain that open design and distributed production overcame the mistakes of indie designers and innovators during the COVID-19 crisis. In this context, we find that the anticipated coordination in Latin America between peers in the region minimized errors and anticipated problems that due to their complexity (distribution, permits, suppliers, etc.) forced them to different solutions from those of the northern hemisphere.

In May 2020, 42 FabLabs participated in the “COVID-19 Survey Fab Lab” (Armstrong et al., 2020) and nine laboratories responded from Argentina, Brazil, Mexico and Peru. In this survey, 48% FabLabs were closed, and 16% partially open. 76% manufactured devices through a distributed network lab and another 14% did so in their laboratories. The largest number of items produced were Face shields. This global context is specified in the different aspects of this research, including external indicators that allow us to understand the projection possibilities of some countries such as Argentina, Chile, Peru, and Mexico in emergency contexts (Activities per country, see Figure 1). They also show the need to stimulate other countries that require not only infrastructure or machines, but also to connect to a distributed collaboration network.

The long-term sustainability of these practices depends on integrating industry, academia, and government, with common objectives that enhance the tasks and actions during the COVID-19 crisis, to continue demonstrating the potential of the region in response to its circumstances and limitations.

## 8. CONCLUSIONS

Despite the fact that society values the quick-short term solutions (Giddens & Sutton, 2018, p.346) and designers compete to solve problems in less time, the speed of contagion and death from this emergency continues to exceed response time worldwide. Although the biggest demands for the designer's role in this emergency have come from the health system and governments, the designers themselves became users of their own products.

In this research, we began the analysis with the total number of Latin American countries (20) that host a total of 134 active FabLabs. We identified that 16 countries had at least digital fabrication infrastructure and machines registered with FabFoundation (FabLab Network, Figure 1). With the experience of the northern hemisphere, this infrastructure would allow the fabrication of medical devices considering the low installed capacity of the health services to face the exponential growth of infections in the region. As we reviewed in this research, COVID-19 spread from Asia to Europe and then to the United States. Once in Latin America, the response of governments was to close borders, start quarantines and impose a mandatory curfew, forcing the community of local fabbers and makers to dimension the problem from two contexts. (a) Global Experience, from the FabLabs of the northern hemisphere with the FabFoundation and (b) Local challenges, from the situation of

Latin America in the FABLAT network. In our analysis, we found positive and negative solutions tested before reaching US and Europe's infections and death numbers. The role of designers and makers changed completely, as analyzed in the section on the scale of design and roles.

The health context and the challenges analyzed revealed the need to create actions, different from the traditional tasks of a FabLab. From Peru, FABLAT established a strategy of action distributed from the global to the personal to fabrication devices (masks, ventilators, connectors, and hermetic boxes). During the first three months of the pandemic, the 15 Fabtalks analyzed promoted the exchange of experiences between 13 countries for "3D printing just-in-time" solutions, in alliance with health services, medicine, industry, academia, and the military. In the confinement situation, we showed that the distribution strategy through the army overcame the device delivery problem that Spain warned us about, caused by the few personnel in the FabLabs and the danger of contagion.

The distribution of participants from Latin American countries showed that Central America did not participate in Awards and Surveys (see Figure 1) but in FabTalks. Colombia, Uruguay, and Venezuela were not linked to the International Design Awards either. The full-time and volunteer dedication of the FabLabs' members focused on manufacturing and awarding their merits was not on the agenda. Universities with a presence in previous versions participated in the Global Grad Show. In the Santander X Challenge existing enterprises adapted to the situation, with services far removed from the proposals developed in the FabLabs.

In the region we find professional associations liked to architecture but not design. The analysis of the design institutions in the northern hemisphere and their ability to develop regulations and standards as a starting point for their members is a point that the region must consider, over the intention of promoting ideas' competitions that contributed very little to the emergency situation.

In the academy section, we consider that the surveys were an opportunity to systematically understand the needs of the confined society, possibilities for remote connection, and the evolution of priorities in a global emergency. Although Design for Emergency, CESUGA and PsyCorona originated in the northern hemisphere, the alliances with universities in the region included them in their research along with other global initiatives. Except for Bolivia, Guyana, Paraguay, Suriname, and Venezuela, 7 countries in South America participated in the surveys analyzed in this research.

FabLabs in Latin America faced the crisis from three contexts analyzed in this research: Open source Design Environment, Distributed fabrication, and the differences between Protected and Open design. As in the northern hemisphere, we found that these ecosystems drove the role of the designer.

Until this crisis, the transition from Do-it-Yourself (DIY) and Do-it-With-Other (DIWO) practices did not evidence a significant global practice to respond to an emergency while it occurs. Informing, evaluating, producing thousands of devices, or detecting needs, requires integrating the infrastructure of a country to face a crisis. Just as in Spain, where the community of makers came together to promote Coronavirus Makers (CVM) (Garcia and Cuartielles, 2020), we identified DIWO ecosystems in Brazil, Peru, and Chile, mainly possible because they have the largest number of FabLabs in the region, promoting the collaboration among its members. The Peruvian FabLabs Network focused on rapid prototyping and

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industrial production with a 4-stage process (with different partners): (a) R + D + I (Laser Amaru and FabLab Furniture); (b) Fabrication (Matritech and FabLab ESAN); (c) Distribution (DICITECE - Peruvian Army); and (d) Monitoring (FabLab Peru). With this initiative, in less than 10 days the cost of face shields dropped from US \$ 25.00 to almost US \$ 5.00 (see Figure 5B). As a whole, there was an acceleration in the foundations of an open source design ecosystem that runs through the main FabLabs in the region.

We hope that this preliminary research, which explored an evolving scenario, will be the starting point for future analysis of new agents and allies in the role of the designer during an emergency, and thus allow us to act proactively in similar situations. This will be possible if we seek equity and drive transformations from communities, articulated with the society that demands them.

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