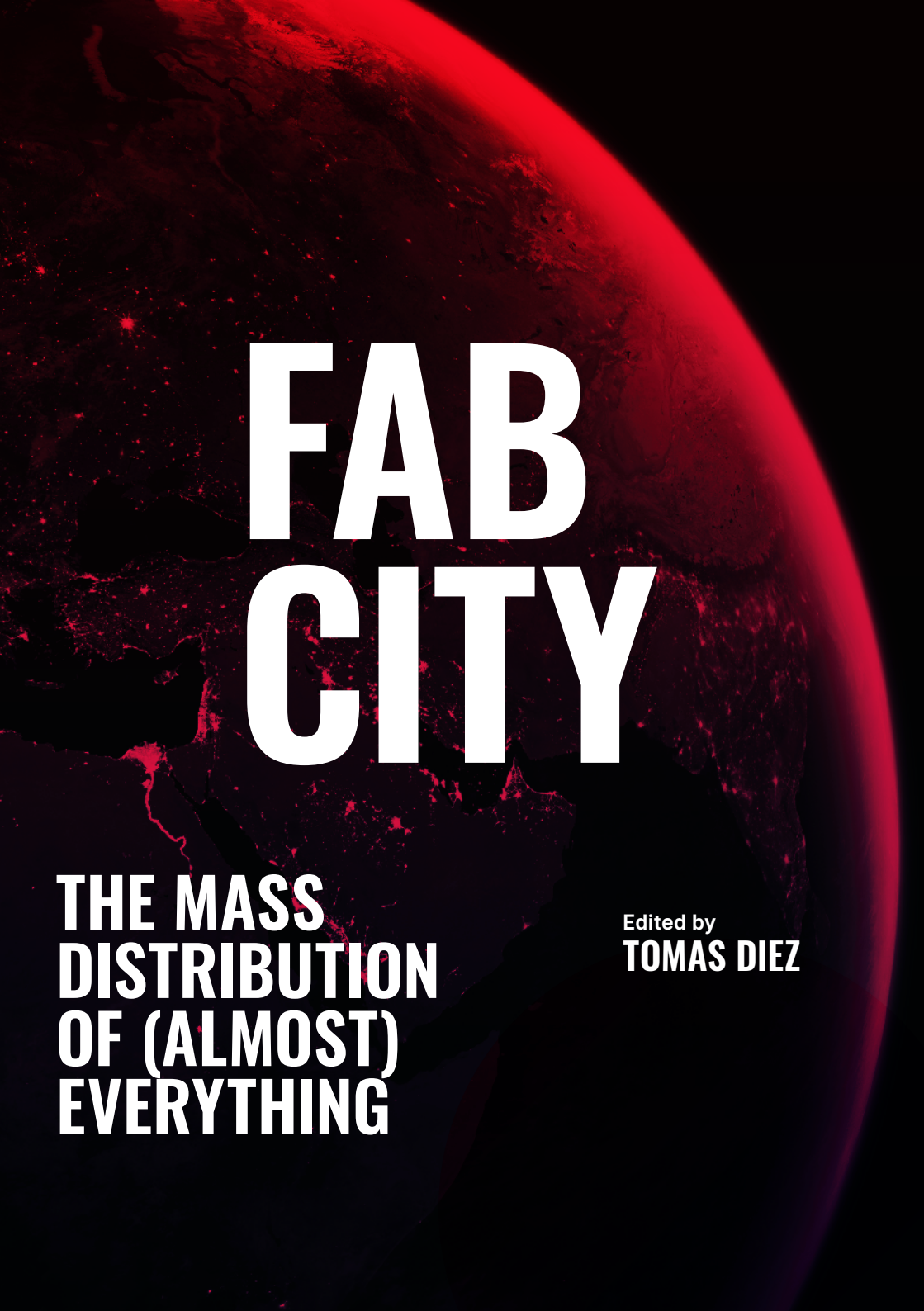

FAB
CITY
THE MASS
DISTRIBUTION
OF (ALMOST)
EVERYTHING
Edited by
TOMAS DIEZ

FAB CITY

THE MASS DISTRIBUTION OF (ALMOST) EVERYTHING

Edited by
TOMÁS DÍEZ

FROM FAB LAB TO FAB CITIES

NEIL GERSHENFELD

I consider the Fab City project to be one of the most important (and unexpected) realizations of the promise of Fab Labs.

Fab Labs began with the modest goal of expanding access to digital fabrication; we never expected to grow exponentially, reaching more than 1,000 Fab Labs, worldwide. As the small network started to grow we began to meet annually. After a few of these gatherings, we started to count them, mostly as a joke, as we also didn't expect them to continue for the following decade. (I'm beginning to see a pattern here). By the time we reached FAB10, in Barcelona in 2014, it was clear that something big was happening.

By then, the team that co-founded the Institute for Advanced Architecture of Catalonia (which is home to Barcelona's pioneering first Fab Lab) had become part of the leadership running the city. The future Mayor of Barcelona (Xavier Trias) visited MIT with the IAAC team in 2011. Barcelona then suffered from (and continues to suffer from) high unemployment, particularly among young people; but it also has a fabulous history of design and urban planning. At that meeting, we described its current operating model as Products-In-Trash-Out and articulated the goal of using digital fabrication to move the city to a Data-In-Data-Out model — under which digital bits of information travel globally, while physical atoms remain local.

This lofty goal led to an initiative to set up Fab Labs across Barcelona, with the understanding that access to the means to make consti-

tutes just an essential part of the urban infrastructure, as electricity or water. That project, in turn, inspired a memorable moment at FAB10, when Mayor Trias pushed a button starting the forty-year countdown to urban self-sufficiency. Barcelona's current Mayor Ada Colau has continued to support this vision, joined by leaders including Paris Mayor Anne Hidalgo, Bhutanese Prime Minister Tshering Tobgay, and the European Commissioner for Science, Technology and Innovation, Carlos Moedas. Forty years was chosen because it's well outside most political and commercial planning horizons, but within individual lifespans. The intention is for this to be a continuous transition rather than a step change, accumulating a few percent each year.

Smart cities are instrumented to provide services more efficiently; a Fab City looks beyond even further, aiming to cross the boundary from digital to physical. This could start with making furniture, say, then progress to building wireless data networks, and then aquaponic systems to grow food. All of these things exist as Fab Lab projects in prototype form today; what remains is to propagate them at scale.

One of the first observations after the button-pushing event was the recognition that today's cities don't even collect the kind of data that would be needed to quantify the fluxes of bits and atoms across their borders. Hence, they would need to collaborate on building the technology base to first measure and then move that ratio. That blind spot began to be filled in as cities joined the Barcelona pledge at subsequent FABx gatherings, all sharing the same clock as that initial button press.

The Fab City initiative was incubated and is now ably led from Barcelona, but like the rest of the Fab Lab network has grown into a global team. It now has its own annual event, including a campus showcasing the latest in Fab City technologies. Pressing the button is the easy part for each of the participating cities; as the countdown continues the bar (and opportunity) is raised for them.

One of the most interesting developments in Fab Cities actually has nothing to do with cities at all. There are a number of Fab Labs in rural locations that are finding that their particular offer of growing local self-sufficiency with global connectivity is leading to what could be called "ruralization" — reversing the drive towards increasing urbanization by providing rural amenities with urban capabilities.

All of this, and more, will be on offer at the Fab City Summit that's happening in Paris in conjunction with FAB14. I look forward to seeing the updates at this year's installment, and to the progress that's surely to come in the future, as we work towards celebrating the end of the countdown.

HOW TO READ THIS BOOK

TOMAS DIEZ

In an ever-changing world, innovation is not an option—it's a necessity. Climate change and social exclusion require us to reinvent our most fundamental systems; a task requiring courage, coherence and long-term thinking. Our voracious appetite, and the rate at which those of us, particularly in urban areas, are consuming resources are putting the systems of our planet—and, consequently, ourselves—at risk. In order to mitigate the potentially catastrophic consequences of urbanization, we must profoundly transform the way we organize production and consumption in cities.

The good news is the transition towards a productive and connected society is not starting from scratch. It began decades ago and is being massified, thanks to digital technologies. We're witnessing the emergence of new ways of growing food, manufacturing products, organizing communities, sharing knowledge, even as we reinvent money, the economy, our approach to treating diseases and challenge the limitations of bodies. The digital world is bringing about fundamental transformations in a host of fields. We must now make those transformations more inclusive and ecological.

On the other hand, the power of making is no longer limited to industry, and neither is innovation. The proliferation of Fab Labs, hackerspaces, and makerspaces around the world has radically expanded access to tools. Today these spaces are democratizing disciplines such as engineering, biology, computation, arts, and fabrication—enabling the global movement of knowledge around how we make things, and how our cities function.

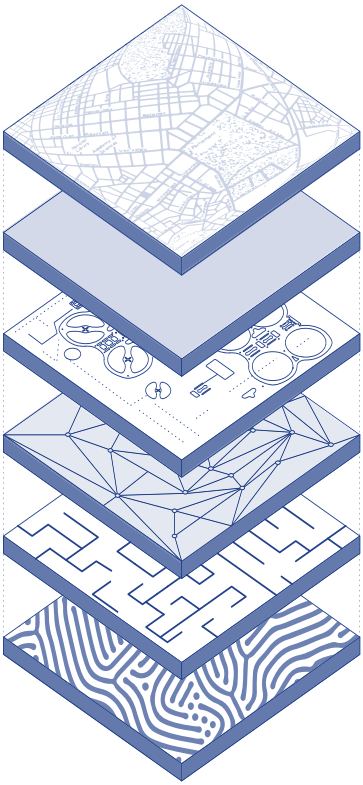
This book is a collection of the experiences and reflections of those who are practicing these new forms of making, and of remaking cities from the ground up. It's a call to action for those who believe in the power of mass collaboration and the distribution of almost everything—from tools to labs, formulas to code, lessons to manuals, blueprints to instructions, plans to strategies. The mass distribution of innovation is happening already, and it is transforming the way we learn, eat, move, live, work, and play in cities throughout the world. We want this book to inspire, want it to be a call for to those who understand that

things need to change, on both the local level and on the planetary scale. We invite you to read this book by randomly selecting articles in any order—and certainly not in a linear fashion. We have collected the contributions from the core instigators of the Fab City Global Initiative, as well as the pioneers who are making it happen, and the players and institutions that are pursuing a new urban future emerging from this network.

This book aims to be many things at the same time: a milestone, a manifesto, a map, a guide, and simply a manual for making engaging urban futures possible... starting today.

FULL STACK

The Fab City Global Initiative is envisioning and constructing possible urban futures by working at multiple and interconnected scales.



Cities Network
Shared metrics to evaluate progress towards self-sufficiency in cities. Policy-making, regulation, and planning for regenerative urbanization.

Platform ecosystem for knowledge sharing
Project repositories for urban transformation. Distributed and decentralized repositories and value exchange mechanisms for global collaboration. Fab Chain, the blockchain project to enable distributed design and manufacturing.

Shared strategies, adapted to local needs
Global programs for urban transformation related to local production and processing of food, energy, water, information, or other production systems. Implementation and deployment strategies by the Fab City Collective. Fab City Prototypes.

Distributed incubation for urban innovation
Engage the power of a distributed network of knowledge to envision, design and create open source technology for urban regeneration. "Grow with Fab" program as a distributed accelerator within the Fab Lab network.

New forms of learning
New skills to ´learn how to learn´, learning-by-doing principles, lifelong learning basis. The Academy of Almost Anything (Fab Academy, Bio Academy, Fabricademy), STEAM education and professional training.

Distributed infrastructure for innovation of digital fabrication
People, communities, spaces (Fab Labs, Makerspaces, Hackerspaces), machines, tools. Thousands of spaces and communities already in place in every major and middle city in the world. Hackerspaces, machines, tools.

CONTENTS

FAB CITY SUMMIT[1]

In the wake of the Paris Agreement and in the midst of the COP21, there is a real and palpable push for nations to adopt the changes needed to transition their economies to a more sustainable and regenerative approach. At this critical juncture, cities must adopt a more daring approach both to transforming local economies and resource management. Cities are the government entity closest to the people; they're where changes could happen most rapidly and where innovation thrives, thanks to density and urban dynamics. The Fab City Global Initiative is making actionable the promises of an urban future built through local empowerment and global collaboration. It scales up the potential of digital fabrication tools in Fab Labs and makerspaces to design, develop, create, and deploy the technologies that will reconfigure the relationship between consumption and production in cities.

This summer, on July 11-13, the annual Fab City Summit will take place in Paris. Previous editions took place in Amsterdam, in 2016, and in Copenhagen, in 2017. The event brings the core team behind the Fab City Global Initiative together with more than 40 city officials, and innovation ecosystems from civic society and industry. The Fab City Summit Paris will be focused on thematic lines, and will not only consider what needs to be done, what is right or wrong, but will also provide a platform for open debate amongst some of the brightest minds grappling with the future of urban life. The event is organised around three days:

- The Fab City Lab, a private (invitation-only) day-long event, held on July 11 in Paris City Hall and bringing together global influencers, decision makers, and experts in urban design and planning, digital and smart manufacturing, and open innovation.
- The Fab City Conference on July 12-13, with high-quality keynote speakers and workshops. Fab City Summit is gathering international experts from a diverse range of fields, including of art, design, politics, economics, industry, architecture, and urbanism. Confirmed speakers include Tomas Saraceno, Saskia Sassen, Indy Johar, Neil Gershenfeld, Danielle Wood, Ron Eglash, Francesca Bria, and Dave Hakkens, among others.

1 Welcome by Minh Man Nguyen, Vincent Guimas, Francesco Cingolani, Kate Armstrong and Tomás Díez.

- The Fab City Campus is to be unveiled on July 14 and hosted at Paris' Parc de La Villette through the end of the summer. Fab City Campus is a short-term intervention that will showcase local and international experiences and prototypes of Fab Cities. It will include exhibitions, workshops for citizens, and guided tours of the local Fab Labs and makerspaces involved in the Fab City project in Paris.

Fab City is global initiative that was launched by Fab Lab Barcelona IAAC, the MIT Center for Bits and Atoms, the Fab Foundation and the Barcelona City Council in 2014, touching off a 40-year countdown to develop a new model for cities to produce everything they consume by 2054. Eighteen cities have followed in Barcelona's footsteps, officially joining the initiative. Other cities have applied and are expected to join the global effort to fight climate change and democratize the access to technology for social innovation this summer, in Paris.

The Fab City Summit is hosted by the Fab City Grand Paris Association, the City Government of Paris, the European Capital of Innovation program, and the Fab City Foundation.

iCAPITAL EUROPEAN COMMISSION

European Capital of Innovation Award (iCapital Awards) for the best urban innovation ecosystems

Cities and the human body operate in surprisingly comparable ways. In healthy environments and under favourable conditions, human organs are the lynchpin of wellbeing, allowing bodies to function properly, and people to focus on seeking material and immaterial satisfaction. Cities are not that different. When the "organs" of a city operate correctly—whether they be public or private institutions—they allow citizens to thrive. Municipal authorities, then, have a dual function. They act as a central nervous system, ensuring the transfer of information; they are also the veins, circulating resources that are essential to the wellbeing of the body.

With the European Capital of Innovation (iCapital) Award, the European Union recognises cities' unique contribution to European prosperity and social wealth, as well as the crucial role that local administrations play in reaching that goal. The cities that have been named European Capitals of Innovation—Paris (2017), Amsterdam (2016), and Barcelona (2014)—actively pursue innovative approaches that are working to making cities more autonomous, sustainable, circular, resilient, and smart. Furthermore, the award is helping strengthen genuinely new ways for city administration to collaborate with one another.

The role of local authorities

Innovation does not work in isolation. It is the result of greater and more complex processes, and as such, it's appropriate to use the term "innovation ecosystems" to describe the ensemble of actors and resources playing a part in the ecosystem. As Europe's economic powerhouses, cities are crucial hotbeds of innovation. Urban areas increase social interactions, and with them, the exchange of ideas and knowledge generation. Although innovation and new technologies often bring challenges and demand constant adaptation, they also come with new resources and talents that enrich companies, facilitate scientific activities and technical

processes, and ultimately help improve and enrich city life. Municipalities play a key role in spurring innovation by enhancing collaboration and interaction between multiple players, including industries, academia, citizens, investors, communication teams, and researchers, to name only a few. Fostering this interaction means generating new ideas and solutions, and local authorities are uniquely placed to support this positive matchmaking. An incredible amount of resources - time, people, skills - are needed to develop structural collaboration and coordination between the authorities and other innovation ecosystem players. Municipalities help provide the necessary infrastructure, like, for example, technology parks, incubators, universities, research labs, and development agencies.

In many cases, stimulating start-up programmes and friendly co-working environments can help support innovative ecosystems. And because innovation does not end with financial injection or laboratory testing, municipalities also play a key role in acting as test-beds for innovation, enabling testing in a real environment, ensuring safety conditions, and enhancing citizen use. Take mobility, for instance. Machine-to-machine communication and self-driving cars are just two examples of innovations that can contribute to safer and less stressful commutes. Cities should play a role in ensuring that citizens place their trust in such innovation and support the benefits that such initiatives promise to deliver.

Cities with innovation in their mind-set

The iCapital Awards also champion inspiring cases of citizen-led and municipality-enabled innovation in cities. The title of European Capital of Innovation comes with 1 million euros in financial incentives. But even more crucial than the money is the recognition that comes with the award: According to the innovation and European affairs officers who compete for the title, such recognition is crucial for city administrators who championing such open approaches to innovation. The award is seen as a stamp of approval, placing the winning city on the European innovation map and making it a role model for others. The award takes into account four different dimensions of local innovation: experimenting, engaging, expanding, and empowering. Experimenting refers to innovative practices of governance and creative city management that exploit untapped potential and synergies.

Take, for instance, Berlin, iCapital finalist in 2017, which brought universities and research institutions together in the Einstein Center Digital Future in order to boost research on the digitalisation of society. On an ordinary day in Tallinn, a 2017 runner-up, you can meet parcel-delivering robots. Self-driving cars were legalized early in the same year, and not only came handy as shuttles while the country held the presidency of the European Council that same year, but also represented an example of public sector experimentation.

Engaging shines a light on citizen-driven initiatives along the whole spectrum of innovation, from design to implementation. Citizens are not passive recipients of innovation but have instead taken an increasingly active role, as “change-makers” and “innovation producers.” Participatory budgeting and calls for citizens' ideas are gaining support in several major European cities. Their application brings tailor-made solutions, additional resources, and strengthens the city's social fabric. In Nice, France, the interactive citizen platform Civocracy brings together 12 citizen organisations to facilitate a unique dialogue with the municipality and has so far come up with more than 250 ideas. Tel Aviv takes a different approach, by issuing an annual challenge that helped the municipality address issues such as parking problems, traffic congestion, and high rents. Each year the municipality allocates resources toward new pilot projects to test the proposed solutions, all of which have been incorporated into mainstream urban practices.

In order to scale up their innovative practices, cities must be able to attract new talents and resources. The expending dimension of the award focuses on the city strategy to appeal to high-skilled workers, investors, and inventors that can raise the potential of a city. As part of this strategy, Toulouse became a hub for the Internet of Things and raised more than half a million euros investments in smart lightening, and spreading the access of 4G in the metro and across the city. In Scandinavia, Helsinki is home to Digitalents, a community that helps young people acquire the basic skills of the 21st century, such as coding, game development, and marketing.

Once cities attract the necessary “know-how,” they’re able to look for new opportunities beyond their city limits and export their successful models to other cities. The expanding dimension of iCapital supports networking and the exchange of best practices on regional, national, and international levels. Another finalist in 2017, Aarhus, recently launched a Danish open-source community bringing together nearly 100 Danish municipalities.

Still, while cities’ status as role models is certainly a source of pride for municipal authorities, ultimately it’s the empowerment of citizens that matters most. This dimension highlights the concrete benefits innovative initiatives have brought to citizens, showing how their living conditions have changed for better. Tampere transformed an industrial district into a carbon-neutral zone that’s home to 25,000 residents and 10,000 new jobs in the circular economy. Who wouldn't like to live in a green area with excellent air quality? In Copenhagen, this is possible. Real-time open data, combined with other indicators such as traffic, is available to help citizens to better plan their daily commute and decide where to rent a flat.

European Commission

EUROPEAN CAPITAL OF INNOVATION

A place to bring ideas to life

iCapital Network. Time for cities to work together

Enhancing innovation and cooperation among local partners is as important as collaboration and dialogue between cities at the national, European, and international levels. Frequent interactions expose good practices and potential synergies. For this reason, the iCapital Awards include all past finalist cities in the iCapital Alumni Network, which currently consisting of more than 20 cities from 12 EU and non-EU states. The network favours the exchange of knowledge and experiences among cities, thus inspiring and helping identify best practices to be replicated across Europe. Closer contacts bring opportunities for new relationships and project partnerships that can scale up current endeavours and impacts.

Paris, the European Capital of Innovation 2017, is well aware of the traction such interactions can help trigger. In addition to playing an active part in global networks such as the C40 and 100 Resilient Cities, Paris took a proactive role in bringing together all iCapital alumni cities at the Fab City Summit 2018. The initiative relies on the power of collaboration and calls upon cities to become more locally productive, self-sufficient, and globally connected. Only together can the European cities adapt to changes in the economic, political, social, and natural environment, and seize new opportunities within existing challenges.

BUILDING BRIDGES FOR CIRCULAR NETWORKS OF FABRICATION

STEPHAN SICARS (UNIDO)

The mandate of the United Nations Industrial Development Organization (UNIDO) is the support of Inclusive and Sustainable Industrial Development (ISID) in developing countries and economies in transition. For 50 years UNIDO has worked towards a truly sustainable industry and recently it has embraced the circular economy concept as a strategic topic consistent with its mandate.

Circular economy is a way of creating value and ultimately prosperity, where products are designed for durability, reuse, remanufacturing and recyclability, and where materials for new products are derived from old products. The circular economy will offer opportunities for networks of small, flexible enterprises for exchange of concepts and knowledge across borders, as well as possibly sharing of manufacturing tasks locally.

The transformative potential of a new wave in digitalization covering technologies of computation, communication, automatization and innovative local fabrication offers the opportunity to enable a transition towards a circular economic model based on a global and distributed flow of data (and knowledge), and local flows of materials.

These technologies have the power to connect global networks of hyper-local infrastructures for fabrication, production and distribution of goods and resources.

Cities, by nature being connected to industrial value chains, can radically transform production and consumption patterns within their metropolitan regions. This could be achieved by adopting strategies that focus on smart customisation, interconnected processes, and most importantly: empowering citizens and communities.

This article looks to the growth and potency of digital technologies as the creative hub of the so called fourth industrial revolution as a transformative force to realise the circular economy. The article also describes UNIDO's commitment to work with the international Fab Lab and Fab City networks consistent with the organization's mandate.

Context

The urbanisation process is closely related to the first industrial revolution, which on one hand created locally large amounts of highly specialised jobs, and on the other hand allowed for the rapid reproduction and replication of largely standardized infrastructure and products around the world. Mainly, urban dynamics in cities of today reflect this standardization and the associated linear economy of manufacture-use-waste. This urban model consumes most of the world's resources and generates most of world's waste.

In many periods of history, urbanization and industrialization have proven to be complimentary drivers for development. Industrialization has acted as a catalyst for urbanization by stimulating economic growth and creating jobs, attracting people to move to cities. Likewise, urbanization has created socio-economic benefits from concentrating people, resources and investment, increasing the potential for economic development, social interaction and innovation.

Similarly, the Fab Lab and Fab City networks can be seen as an innovative way to link urbanization and industrialization in today's world. Several advanced economies are already implementing the concept of Industry 4.0, marking the Fourth Industrial Revolution. Increasingly, companies are applying innovative solutions, including the "Internet of Things" (IoT), cloud computing, miniaturization, and 3D printing that will enable more interoperability and flexible industrial processes and autonomous and intelligent manufacturing.

Using these and other concepts of Industry 4.0 for circular economy purposes has the potential to improve competitiveness, labour conditions and local community well-being. In addition, using Industry 4.0 this way will substantially increase energy and resource efficiencies and hence

decrease the use of natural resources and protect the environment. UNIDO's mandate, to support inclusive and sustainable industrial development (ISID), is fulfilled very well by applying industry 4.0 to circular economy. The structures that Fab Labs and in particular Fab Cities form, with groups of SMEs cooperating matching innovation with experience and capacity, help to create "inclusive" development because many persons with diverse backgrounds participate and benefit, and "sustainable" development since their activity helps to reduce natural resources use and negative environmental impacts.

Inherent to industry 4.0 technologies is the power of open source hardware and software solutions. Recently, 'blockchain' based applications have shown their transformative potential to provide authenticated data communication between each player in a supply chain without the intermediation of a trusted central organization. With that comes transparency and material traceability, reduced administrative costs, lower risk of fraud and grey market trading and better control of outsourced contract manufacturing.

Constantly evolving digital technologies have the capacity to support UNIDO's work and its projects, such as: circular economy initiatives, eco-industrial park developments, and contribution to sustainable cities. Collectively, these developments will lead to the emergence of more sustainable production and consumption patterns, and could thus provide opportunities for developed and developing countries alike to achieve economic growth in line with the 2030 Agenda for Sustainable Development.

Opportunities for collaboration

As mentioned, Fab Labs and Fab Cities can be agents of change towards a more inclusive, environmentally friendly way to operate the economy. UNIDO's Department of Environment wishes to explore the possibilities to collaborate with the network of Fab Labs. We see interesting and promising options for developing relations and interactions between Fab Labs, normally located in urban areas, with nearby artisans and small-scale conventional manufacturers, as well as with industrial facilities located in peri-urban areas. Collaborations in industrial applications of eco-design, and industrial processes of acquisition, reprocessing and remarketing could be explored.

The main focus will be on the circular economy principle, which will be catalyzed by the use of new digital technologies and logics of production that are part of the Industry 4.0 paradigm. UNIDO believes that the use of robotization, artificial intelligence, 3D printers and other innovative technologies for production, as well as the raising of open source and distributed knowledge management will most likely have a major impact

on the development of circular economy. Circular economy faces widely distributed goods far from their original manufacturers, which need to be to be renewed and improved for better experience wherever they are; this needs facilities and networks in and around urban centers, but the necessary know-how can be blended from different sources, either local or over long distances. We therefore see working with industry 4.0 and digitalization solutions in developing countries to have a significant potential to support UNIDO in fulfilling its mandate.

UNIDO related environmental work supports circular economy models, in particular for developing economies. Many of our projects already address various building blocks of a circular economy and can be linked with industry 4.0. Some projects support cleaner manufacture of products, others help develop safe, easy-to-recycle products with longer lifetimes and still others deal with resources recovery. Future projects will focus substantially on extending product life and innovative solutions for upcycling. UNIDO projects contribute to the restructuring of value chains towards a circular flow of materials, achieving reduced resource consumption.

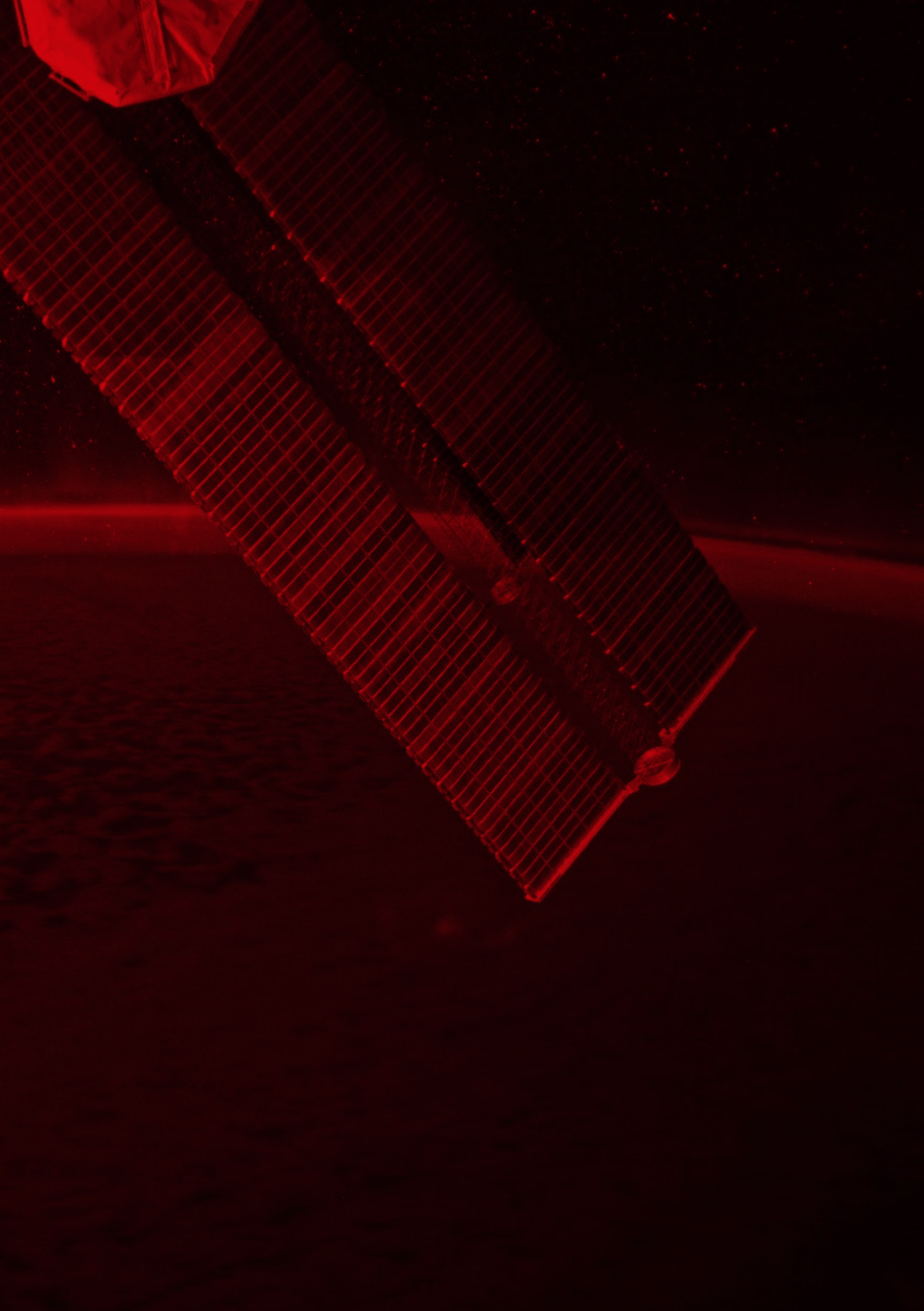
Another good example of this linkage is the UNIDO works on eco-industrial parks (EIPs), where industrial synergies between different companies are fostered and could greatly benefit from open source and distributed knowledge. EIPs are also strongly interrelated with UNIDO sustainable cities programme. The role of cities in the context of the circular economy and the Industry 4.0 paradigm is paramount, as they are the most important beneficiaries and actors of the linear economy and, at the same time, the biggest centers where circular economic solutions are currently developed.

In this respect, the city will have to redefine its relationship with the industries located in the surrounding or peri-urban areas, in order to maximize the efficiency in resources and wastes management. Here, the link between SMEs, normally located in urban areas, and facilities or industrial parks, placed in peri-urban areas, will be of high importance.

UNIDO is in support of the Fab City initiative, involving citizens in a more sustainable urbanization, where ecological systems are developed around the whole life cycle of products, where the flow of materials is circularized and energy more efficiently consumed. This initiative is a great opportunity for participating cities to advance their transition towards circular economy. It will create new types of jobs and professions related to the knowledge economy and the development and implementation of new approaches and technological solutions. The circular economy is the sustainability framework that supports the emerging fourth industrial revolution, and UNIDO is the partner for Fab Lab and Fab City networks sharing this vision.

ENABLING EMERGENT FUTURES

A CONSTRUCTIVE OVERVIEW FOR THE FUTURE OF CITIES, TECHNOLOGY AND SOCIETY



FAB FUTURES: THE POWER OF NETWORKED IMPACT

SHERRY LASSITER

In 2003, the first true Fab Lab was established in inner-city Boston. Politician, professor, writer, and community activist Mel King was its champion. Mr. King was constantly exploring new technologies for our inner city community, which was largely black, urban, and often left behind. “The rear wheels of the train never catch up to the front wheels, unless something radical happens.” He believed that digital fabrication was a way for youth in his community to jump ahead and lead our technological future.

Just a few years later, Haakon Karlsen started a Fab Lab in northern Norway, 1,500 kilometers north of the Arctic Circle. He, too, was a community leader, the descendant of Vikings and Sami Herders. He built his lab in a Viking longhouse to bring advanced technical education to the children of rural Norway and to help local entrepreneurs bring their ideas to life. He believed that the growing Fab Lab network was a community of people who wanted to share knowledge and collaborate.

These two pioneers helped inspire the global Fab Lab network, a network that is about more than machines and technology. Yes, it is a community of people who want to share knowledge

"FAB LAB NETWORK, A NETWORK THAT IS ABOUT MORE THAN MACHINES AND TECHNOLOGY."

"THE FAB ACADEMY, IS A DISTRIBUTED CAMPUS FOR ADVANCED TECHNICAL EDUCATION."

"AS FAB LABS MATURE AND ARE ABLE TO PRODUCE BETTER QUALITY AND INNOVATIVE SOLUTIONS."

and collaborate. But the participants are change agents, who use technology as their catalytic platform. With common vision and a worldwide distributed technology infrastructure, the community is able to collaborate and act in broad and powerful ways—in education, humanitarian aid, and research collaborations.

The Fab Academy, for example, is a distributed campus for advanced technical education. Each Fab Lab that participates is a classroom in this global campus. Peers and mentors work together in their Fab Labs; connect to other Fab Labs to share knowledge and expertise; and together celebrate the ideas, the technical solutions, and the creativity of each student. Some of the ideas are big, and some are small, but they all are interesting, and in most cases just as exciting as the innovations we see coming out of MIT. There are about 80 Fab Labs participating in Fab Academy this year, with several hundred students from India, Kenya, Iceland, Spain, the U.S., Peru, Chile, as well as many other countries taking part. The people who teach and mentor the Academy are extraordinary technology innovators and are among one of the most impressive groups of people within our network—intimate, action-oriented, and definitely changing the world of education, as well as entrepreneurship.

Humanitarian aid has become a salient point of interest for many in the network over the past few years. As Fab Labs mature and are able to produce better quality and innovative solutions, the humanitarian sector is reaching out to the community, seeking easily deployable innovations for small-scale manufacturing and for makers who can become humanitarians in the field. Small, flexible aid organizations like Field Ready and Terre des Hommes, are putting Fab Labs into refugee camps and using digital fabrication to support field operations. While still in its early stages, this work holds great promise for large and impactful network action.

Research collaborations are another way the network takes action. The Machines that Make Machines project started at MIT but has grown into a global project. Fab Labs all over the world are making machines: 3D printers, milling machines, routers, lathes, 5 axis wire cutters, scanners, paint droppers, cocktail mixers, even Zen garden designers. From the practical to the whimsical, there is no end to the types of machines that can be made in Fab Labs. What's more, most fabricators freely share their designs for others to follow. It costs around the

order of $120,000 to buy a Fab Lab, but once you have one lab, you can then use the machines to make another. In other words, Fab Labs can self-reproduce for 1/10th of the original price, making digital fabrication far more affordable, and thus democratizing access to the technology tools for innovation. And it's not just a single individual doing this work; rather, it's a global community collaborating—a network of expertise and invention.

"OUR WORK IS TO BUILD A FULL-STACK INFRASTRUCTURE TO DEMOCRATIZE ACCESS TO DIGITAL FABRICATION TOOLS."

The Fab Foundation was established in 2009, largely as an effort to support the growth of the international network. We spent our first 10 years building Fab Labs in communities across the world, and developing the educational tools to help those labs and communities create new microenterprises and solve their own local technical challenges. We have largely achieved our goal: Today, there are more than 1,200 Fab Labs in more than 100 countries, and each lab shares a common set of tools and processes.

Today Fab Foundation supports regional networks and the promising projects and innovations that emerge from within these networks in order to help them reach their potential in the world in sustainable and impactful ways. We have seen extraordinary regional leadership emerge in many parts of the world, forming effective, collaborative local networks in countries and regions including the Netherlands, Spain, Iceland, Japan, India, Brazil, South and Central America (FabLAT), Asia (FAN), and China. These regional networks are becoming powerful voices and actors in our work, spurring innovation in programs and projects, such as the Fab Academy and Fab City, that are changing the way we educate and live in our world.

"THIS RESEARCH WILL HELP US ESTABLISH NEW PATHWAYS FOR LIVING AND WORKING IN THE 21ST CENTURY CITY."

Fab Labs buck the traditional ways of running organisations, educational programs, and businesses. The way this network has grown, and keeps growing, empowers new generations that constantly push us to reformulate the way we learn, live, work, and play. The fundamental role we see for Fab Labs and Fab Cities is to catalyze this process in urban and rural areas, welcoming those who don't fit into traditional systems or formal educational programs, and offering enabling, empowering opportunities for those who've been left behind economically. New innovation ecosystems in cities, governments, and local industries will play a critical role in the transition toward a more inclusive and generative economy—one where technology is a key element, but not the central

element. We take a holistic view of this future, our mission being to enhance human capabilities in such a way that we become the best version of ourselves.

"FAB LABS BUCK THE TRADITIONAL WAYS OF RUNNING ORGANISATIONS, EDUCATIONAL PROGRAMS, AND BUSINESSES."

We are poised at the transition between the 3rd and 4th Industrial Revolutions, moving from an industry based on automation, computers, and electronics to an industry that incorporates Cyber Physical Systems, the Internet of things and networks[1]. New technologies are developing so quickly that we really don't understand what the technologies will look like even just 10 years from now. It follows, therefore, that we don't know what skills the future workforce will need, either. How do we best prepare our youth for that future, and how do we retrain the current workers in the skills they'll need to play an active role in that future?

Education is one of the core pillars of the Fab Foundation's work and one of the pathways we use to bridge the digital divide. I believe the Fab Lab Network is uniquely positioned to support the kind of education needed to forge technically prepared, lifelong learners. Through the Fab Academy we are exposing adults to transdisciplinary knowledge and learning, to design, media literacy, computational thinking, collaboration, communication, and the technical skills to leverage digital fabrication for work and for entrepreneurship. With the SCOPES-DF project we are doing the same for our youth. This broad and flexible base of knowledge, along with the skills to learn how to learn, will be critical to participating in the work of the 21st century.

"HOW WILL WE PROVIDE SOCIAL SECURITY, HEALTH AND FINANCIAL WELL-BEING?"

As we are pulled into Industry 4.0, we must carefully consider how to build the educational systems of the future; how to provide access to digital fabrication for al; and also how to establish sustainable, equitable practices and participation in industry. And thinking beyond the purely technical realm, we need to address what will happen to the social benefits and safety nets that support us all once the workplace becomes less centralized and more distributed. If we embrace a brave new world of decentralized industry, and more of us join the gig economy, how will we provide social security, health and financial well-being?

1 "Industry 4.0: Trade Rules for the Internet of things," by Ed Gerwin, June 22 2017, *tradevistas*, retrieved 6-01-2018 from: https://tradevistas.csis.org/industry-4-0-trade-rules-internet-things/

BLOCKCHAIN: A GLOBAL INFRASTRUCTURE FOR DISTRIBUTED GOVERNANCE AND LOCAL MANUFACTURING

PRIMAVERA DE FILIPPI

"WE NO LONGER NEED TO LIVE IN THE SAME AREA, OR MEET FACE TO FACE, IN ORDER TO COLLABORATE ON A COMMON ENDEAVOUR."

The arrival of the Internet and digital communication tools have led to the emergence of new "paperless organisations" that operate without an office, schedule, or even employees. With the Internet, we can now work remotely, synchronously and asynchronously, without having to physically move from place to place. We no longer need to live in the same area, or meet face to face, in order to collaborate on a common endeavour. We simply need to connect to the Internet network to find colleagues, partners, or customers. The hope was that this global communication network would eventually lead to increased participation and greater opportunities for people all over the world to play a part in the global economy. And to some extent, it did.

Yet, the shift was only a partial one. Over the past 20 years, we have progressively moved away from the traditional model of centralized organisations, where large operators (often with a dominant position) were responsible for providing a service to a group of passive consumers. Today, we are witnessing the emergence of new organisational structures in the digital domain that are much more distributed in nature. These so-called "crowdsourced organisations" are responsible for aggregating the resources of multiple people to provide a service to a much more active group of consumers. Indeed, if we look at the modus operandi of today's Internet giants—such as Google, Facebook, Twitter, Uber, or Airbnb—we see they have one thing in common: They rely on user contributions as a means of generating value within their own platforms. The problem with this model is that, in most cases, the value produced by the crowd is not equally re-distributed among all those who contributed to that value creation. Instead, the lion's share of profits ends up being captured by the large intermediaries that operate the platforms.

"NEW OPEN SOURCE HARDWARE AND SOFTWARE TOOLS FOSTERS NEW MODES OF LEARNING, DESIGNING, MANUFACTURING."

Conversely, in the physical domain, the development of new open source hardware and software tools over the past decades has fostered new modes of learning, designing, manufacturing, and collaborating that actually promote individual participation in an open ecosystem of value creation and re-distribution. Inspired by the Open Source movement in software, maker communities have been building new hardware-based technologies and tools inside new fabrication spaces. Today, millions of people are connected to the Internet through open source software and use digital fabrication tools (including 3D printing) to build the largest distributed design and manufacturing ecosystem in the world. This paves

the way for a more equal redistribution of production means, both digitally and physically. And yet, as occurred with the Internet a few decades ago, the value generated by makers is likely to be captured by rising manufacturing and distribution giants. How can these communities govern themselves without falling into the same centralized paradigm that has become so prevalent within the sharing economy?

Recently, a new technology has emerged that could help answer that question. Blockchain—the technology that underpins Bitcoin—facilitates the exchange of value in a secure and decentralized manner, without the need for an intermediary. As such, it enabled the emergence of virtual currencies and other distributed ledger technologies that look likely to disrupt existing intermediaries in the financial sector, and beyond.

"BLOCKCHAIN FACILITATES THE EXCHANGE OF VALUE IN A SECURE AND DECENTRALIZED MANNER, WITHOUT THE NEED FOR AN INTERMEDIARY."

But the most revolutionary aspect of blockchain technology is that it is also a means for individuals to coordinate common activities, to interact directly with one another, and to govern themselves in a more secure and decentralized manner. Indeed, modern blockchain-based networks make it possible for people not only to transact value between one another, but also to execute software in a secure and decentralized manner. With a blockchain, software applications no longer need to be deployed on a centralized server: They can be run on a peer-to-peer network that is not controlled by any single party. These blockchain-based applications can be used to coordinate the activities of a large number of individuals, allowing them to organize without the help of a third party.

"BLOCKCHAIN-BASED APPLICATIONS CAN BE USED TO COORDINATE THE ACTIVITIES OF A LARGE NUMBER OF INDIVIDUALS, ALLOWING THEM TO ORGANIZE WITHOUT THE HELP OF A THIRD PARTY."

There are already a few such applications that have been deployed on a blockchain. For instance, Steemit, Sapien, and Akasha are distributed social networks and media platforms that operate without a centralized authority. Instead of the content being stored on a centralized server, operated by a centralized organisation that can control and manage the content that is displayed to the public, these platforms stores content on a decentralized network, using blockchain technology to coordinate individuals and manage the content they contribute to the platforms through a set of code-based protocols and rules.

Similarly, OpenBazaar is a decentralized marketplace, like eBay or Amazon, that operates independently of any intermediary operator. The platform relies on the Bitcoin blockchain to ensure that buyers and sellers interact directly with one

another, without passing through any centralized middleman. Anyone is free to offer a product for sale on the platform at a given price. Once a buyer agrees to the price for that product, an escrow account is created on the blockchain, requiring two out of three people (i.e., the buyer, the seller, and a potential third-party arbitrator) to agree for the funds to be released (a so-called multi-signature account). Once the buyer has sent the payment to the escrow account, the seller ships the product, and after receiving the product, the buyer releases the funds from the escrow account. Only if an issue arises will the system require the intervention of a third party (e.g., an arbitrator) to determine whether to release the payment to the seller or return the money to the buyer.

There have also been some attempts to create a generic infrastructure for decentralized organisations, such as DAOstack and Aragon, which provide the basic building blocks for creating decentralized crowdsourcing organisations, administered without a centralized operator. These organisations are governed by the code deployed on a blockchain-based infrastructure, which is designed to govern peer-to-peer interactions between multiple actors.

"BLOCKCHAIN TECHNOLOGIES CAN SUPPORT A MUCH MORE COOPERATIVE FORM OF CROWDSOURCING."

"USERS ARE CONTRIBUTORS TOO, AND SHAREHOLDERS OF THE PLATFORMS TO WHICH THEY CONTRIBUTE."

Blockchain technology thus facilitates the emergence of new forms of decentralized organisations, which have neither a director nor a CEO, nor any sort of hierarchical structure. These organisations are administered collectively by all the individuals interacting on the blockchain. As such, it is important not to confuse them with the traditional model of "crowdsourcing," where people contribute to a platform but don't actually benefit from its success. On the contrary, blockchain technologies can support a much more cooperative form of crowdsourcing—sometimes referred to as "platform cooperativism"—where users are contributors too and shareholders of the platforms to which they contribute. And since there is no intermediary operator, the value produced within these platforms can be more equally redistributed among those who have contributed to the value creation. With this new opportunity for increased "cooperativism," we're moving toward a true sharing or collaborative economy—one that is not controlled by a few large intermediary operators, but rather governed by and for the people. Blockchain technology makes it possible to replace the model of top-down hierarchical organisations with a system of distributed, bottom-up cooperation. Ultimately, this shift could change the way wealth is distributed in the

first place, enabling people to cooperate toward the creation of a common good, while ensuring that all involved are duly compensated for their efforts and contributions.

While most of these blockchain-based organisations have so far been developed mostly to facilitate the coordination of individuals in the digital world, the possibilities resulting from these new organisational structures can also be found in the physical world. Cities, municipalities and local communities can leverage the power of blockchain technology in order to increase transparency and accountability in many sectors, while providing new opportunities for anyone to engage and participate in the local economy. Indeed, blockchain technology is currently being explored as a way to support local energy microgrids with peer-to-peer exchanges between neighbours (see, e.g. Grid Singularity), or to provide more transparency in the food supply chain (for instance, with projects such as Provenance) by recording information in the form of immutable cryptographic records on a distributed ledger.

"THERE ARE NEW OPPORTUNITIES FOR ANYONE TO ENGAGE AND PARTICIPATE IN THE LOCAL ECONOMY."

Digital technologies create many new opportunities to increase the capacity of local production within communities, neighbourhoods, and cities through urban farming technologies (aquaponics, aeroponics, synthetic biology), solar panels or wind turbines, and digital fabrication tools (from personal 3d printers to flexible factories). These technologies could result in significant operational efficiencies by reducing production costs and unleashing new business opportunities for manufacturers worldwide. Yet, the question of governance remains a critical one that still must be properly addressed. Indeed, in the physical world, commons-pool resources are subject to the "tragedy of the commons": without a proper governance structure or incentivisation scheme, people are likely to free-ride, leading to over-exploitation and/or under-contribution to these common-pool resources. In order to increase the chances that these new technologies contribute to the flourishing of a healthy ecosystem of local production, we need to identify the proper incentivisation mechanisms that will encourage people to contribute resources, without being subject to the scrutiny of a centralized authority.

"ENABLING LOCAL PROCESSES OF PRODUCTION TO REDUCE THE IMPACT OF THE CURRENT INDUSTRIAL GLOBALISATION IS CRUCIAL."

Enabling local processes of production to reduce the impact of the current industrial globalisation is crucial, but enabling mechanisms to incentivise, accelerate, and scale this process is fundamental and urgent. This is where blockchain

"ENABLING MECHANISMS TO INCENTIVISE, ACCELERATE, AND SCALE THIS PROCESS IS FUNDAMENTAL AND URGENT."

technology could come in handy, by creating an open platform and decentralized incentivisation scheme that can be articulated between multiple stakeholders. Local communities have been experimenting with local currencies for a long time, but because of the limited scope, they haven't yet managed to reach a global audience. For instance, with a blockchain, multiple cities around the world could incentivise local communities to contribute to the commons and engage in productive and collaborative activities by rewarding these practices with a global social impact currency. This would enable local communities to coordinate on a global level, in order to promote a paradigm shift in terms of recycling, reuse, relocalisation of supply chains, and other practices that reduce the impact of the linear economy.

"THERE IS ALWAYS THE RISK THAT BEHEMOTHS WILL ALSO EVENTUALLY EMERGE IN THE BLOCKCHAIN SPACE, JUST AS IT HAPPENED WITH THE INTERNET."

The opportunities are huge, and yet nothing should be taken for granted. The decentralized potential of blockchain technology does not necessarily mean that it will, in fact, be used in a decentralized manner. Just as the Internet has evolved from a highly decentralized infrastructure into an increasingly centralized system, controlled by but a handful of large online operators, there is always the risk that behemoths will also eventually emerge in the blockchain space. If we as a society really value the concept of a true sharing economy, where disparate groups of individuals can coordinate and cooperate on a peer-to-peer basis, and those producing value are fairly rewarded for their efforts, it behoves us all to engage and experiment with this emerging technology, exploring the new opportunities it provides and deploying large, successful, community-driven applications that enable us to achieve the promises of a true collaborative economy within the context of new productive cities.

"ENGAGE AND EXPERIMENT WITH THIS EMERGING TECHNOLOGY ENABLE US TO ACHIEVE THE PROMISES OF A TRUE COLLABORATIVE ECONOMY WITHIN THE CONTEXT OF NEW PRODUCTIVE CITIES."

ARTIFICIAL INTELLIGENCE AND URBAN COMMUNITY MEMORIES

LUC STEELS

The rapidly burgeoning human population, with its spiralling numbers of city dwellers living urban lifestyles, demands an extremely efficient use of resources, particularly for transportation, communication, food provisioning, and manufacturing. For many cities, the population explosion has already proven too much to handle, leading to unbearable pollution, chronic health problems, deep inequality, and political paralysis due to lost cultural coherence. It is within this context that the Fab Lab movement was born. The empowerment of citizens and equal-opportunity access to resources, manufacturing, and distribution are its key tenets. Information technology is a critical component to the Fab Lab strategy, and Artificial Intelligence is the icing on an IT cake.

Artificial Intelligence

Artificial Intelligence, or AI, has become a hot topic of late, as the pendulum has swung from widespread underestimation (the dismissive notion that AI will never work and is useless) to near-universal overestimation (the idea that AI will soon lead to superintelligence and overtake the human species). The truth lies somewhere in the middle. Yes, AI can be very useful. But that doesn't mean it's going to lead to superhuman intelligence anytime soon. Proponents of the latter theory either totally underestimate the human mind and the force of human collaboration, or they're wildly mislead as to exactly what AI can achieve today—probably due to a dangerous cocktail of limited technical competence and overexposure to propaganda from companies with large stakes in AI.

"AI IS NOT A SINGLE OBJECT OR PROCESS BUT A LARGE AND GROWING ARSENAL OF INSIGHTS, METHODS, AND TECHNIQUES FOR ADDING INTELLIGENCE TO INFORMATION SYSTEMS."

It's important to keep in mind that AI is not a single object or process but a large and growing arsenal of insights, methods, and techniques for adding intelligence to information systems. Deep Learning is just one of these techniques. Other examples include reinforcement learning, the representation and acquisition of vast knowledge networks (such as Google's Knowledge Graph, with its more than 70 billion facts); grammars and dialogue strategies for conversational agents (such as SIRI); sophisticated implementations of logical inference; and many others. Each application requires different

AI components, some of which already exist and others that are yet to be developed. Components must always be adapted to the task, through processes including machine learning of statistical models on big (and small) data; "reading" texts, such as Wikipedia or scientific papers; and through careful design decisions to determine which algorithms should be used and how they will interact. In any case, a critical component of AI is the availability of data and knowledge. There's no magic!

Obviously, AI has potential applications across the entire manufacturing process. It can help in defining functionalities such as what to produce, in what quantities, by better tapping into the customer base and recognizing feedback patterns among users of existing devices. It can help in design by making it possible to search through a huge set of existing solutions, or propose adaptations that fit with the intended purpose of a new design. It can help in the manufacturing process itself by automatically programming machine tools with high-level specifications, or by controlling flexible robotic tools. It can also help in quality control—and, in fact, quality control has become AI's main application in manufacturing today. Finally, it can help in orchestrating the distribution and transportation of products. AI is already being used in centralized manufacturing for all these functions, and there's no doubt it will play an ever-larger role in the kind of distributed digital manufacturing that's practised by Fab Labs. Many in the Fab Lab community will particularly applaud AI's increasing role in designing objects and automatically programming Fab Lab tools.

But in the rest of this essay I'll focus instead on the other aspect of the Fab Lab strategy—namely, how to make better, more liveable cities by empowering citizens. Today, the term "smart city" refers largely to gathering more data about the activities of citizens and the state of the urban environment. However, all this data is useless if it's not followed up on with powerful data analytics, in which AI is playing an increasingly important role. Moreover, a lack of citizen understanding about the type and extent of data gathered on them will lead to a sense of disempowerment. Citizens must be able to visualize this data themselves and see the consequences of their actions. It's obviously preferable that citizens themselves

"A LACK OF CITIZEN UNDERSTANDING ABOUT THE TYPE AND EXTENT OF DATA GATHERED ON THEM WILL LEAD TO A SENSE OF DISEMPOWERMENT."

engage in data gathering and provide computational resources or expertise in data interpretation, rather than the data being gathered behind their backs, via hidden sensors, and processed by private companies without any oversight.

Community Memories

Quite a few projects in several Fab Labs have been trying to make this vision a reality. Here, I'll hone in on case studies about pollution, which in its many iterations (air, water, soil, food) of course constitutes one of the main worries of big-city residents. Pollution, however, is a largely invisible and a silent killer—that is, until it's quantified and made public. Systematic measurement is more complicated than it sounds. Not all players want the numbers to be made public: Revealing the extent of pollution affecting a given neighbourhood could have palpable consequences for economically powerful entities. Also, concrete facts and figures can help shape public opinion and, thus, political consensus on such sensitive subject as car use or whether to allow the docking of cruise ships. So how can citizens be empowered to pressure their government to be concerned with the common good? How can a consensus be established?

"SO HOW CAN CITIZENS BE EMPOWERED TO PRESSURE THEIR GOVERNMENT TO BE CONCERNED WITH THE COMMON GOOD?"

Around 2005, I introduced the notion of a community memory (Steels, 2007) as a fundamental information structure to help in the collective management of "commons"—the things we share, such as water, air, oceans, fertile land, space, money, and resources for handling mail. The Nobel Prize-winning economist Elinor Orstrom (1999) has argued that it's neither the state, nor the market that are the best-suited for managing the commons, but rather those who are directly affected. But putting that principle into practice is difficult. The tragedy of the commons occurs all too readily: Often, there are members of the community who take more than their fair share; there are those who are only users, and not providers; those who are, in effect, destroying the commons. All cases of pollution boil down to a tragedy of the commons. When people decide to take their car to work, they're effectively using the air—a common resource—and partially compromising its quality for everyone else. Those drivers are also taking up space on roads

and parking spots. If too many others are doing the same, the air quality gets to a point where nobody can breathe, where the roads are so clogged that nobody can move, and where critical green spaces are paved over for parking.

A community memory is designed as a tool to help communities manage their commons. The term "community memory" dates back to the 1970s, in reference to the first electronic bulletin board set up in Berkeley, California (Colstad and Lipkin, 1975). The system became a forerunner for many shared networks and information sources, such as the World Wide Web, or social media like Facebook. The term came up again in the 1980s, when the focus of AI began to shift away from reaping knowledge from an individual expert to harnessing the encyclopaedic knowledge of a community (Steels, 1989). At that time, however, the term community memory didn't yet refer to a tool for managing a commons.

Over the past two decades, community memory came to be seen as a distributed information structure, crowd-sourced with data, commentaries, and knowledge provided by community members for keeping track of their commons—thus instilling a sense of responsibility so that everybody takes better care of the commons and coordinates its production and usage. It now routinely uses AI to create insightful maps, detect trends, predict the future evolution of the commons and the consequences of certain actions, as well as explanations for all this through natural interfaces, like human language. A community memory should be public and accessible, at least by the community members, through a continuously updated web page, for example.

Although the dream of community memories was already in existence at the beginning of the 21st century, turning it into a reality has required a number of non-trivial enabling technologies, in addition to the software tools for setting up and running the community memory itself. Many of these technologies are now in widespread usage; others still have to mature. Those that are already readily available include the following:

"THE DREAM OF COMMUNITY MEMORIES WAS ALREADY IN EXISTENCE AT THE BEGINNING OF THE 21ST CENTURY, TURNING IT INTO A REALITY HAS REQUIRED A NUMBER OF NON-TRIVIAL ENABLING TECHNOLOGIES."

1. Near-universal Internet access, and the democratization of the tools for setting up and maintaining websites. This has largely been achieved, due, in part, to the availability of the web and other Internet tools on mobile phones.

2. Tools for social networking among community members. This has also been largely achieved through the exponential rise of social media, which began around 2005 and exploded in 2010.

3. Facilities for geomapping, which is an important aspect of many common resources that include spatial location. This has also been achieved thanks to the widespread availability of maps and geolocation embedded in a variety of devices, including mobile phones.

Enabling technologies that are not yet so widespread include:

A. Ways to access large computing resources without the cost (and pollution) of centralized supercomputing centres. Such computer resources are needed for data processing, data storage, AI, and simulation. I'm not able to discuss the issue further here due to page limitations, but See Hanappe (2010) or D'Hondt *et al.* (2012) for concrete experiments in how communities can harvest huge computer resources by banding together and using laptops, mobile phones, game stations, and even television sets.

B. Devices for participatory sensing, so that members of a commons are able to perform measurements and upload them to the community memory. The remainder of this essay delves into this aspect, partly because Fab Labs have played a significant role in it. My focus will be on examples of air pollution monitoring.

Participatory sensing of air pollution

Around 2005, the first consumer-oriented smart phones started to appear, and with them, the possibility of using them for participatory sensing. There are official institutions measuring air quality in all cities, such as airparif in Paris (https://www.airparif.asso.fr). However, such sites are often hampered by drawing on too few measuring points. (Pollution levels can differ greatly from one side of a city to another.) Therefore, the prospect of using distributed participatory sensing was welcomed by many, including action groups that were frustrated by sluggish government action. Several projects began to take shape, such as the Participatory Urbanism Project, from Intel Research Berkeley, or the DAPPLE project at UC London. Together with Eugenio Tiselli, who already worked on community memory-like projects with artist Antoni Abad in Barcelona, we developed a first prototype for using smart phones for participatory sensing of pollution at the Sony Computer Science Laboratory in Paris in 2006, attaching a low-cost Nitrogen Dioxide (NO_2) sensor to a phone using an Arduino Bluetooth microcontroller that could send sensor data to a Symbian NOKIA smartphone. The phone was able to log the data, along with time and geolocation information, and send it via MMS to a web server. Users could also add tags to record their own experience. The data was then aggregated and projected on maps.

However, experiments in the streets of Paris throughout the course of 2007 made it clear that it was not possible to get scientifically reliable measurements to the standards required by official institutions. The measurements were certainly not admissible in the kinds of lawsuits that citizens are now increasingly launching against city governments that fail to act to curb air pollution. The main issue was finding reliable but not-too-expensive sensors and consistently calibrating them properly. Like most other sensors, NO_2 sensors are sensitive to many aspects of the environment, and getting relevant data requires those other factors to be reliably measured, as well. In addition, sensors may demon-

strate spurious behaviour, requiring constant supervision, and they also need to be used in conjunction with top-down modelling, in order to reduce noise and avoid erroneous outliers. Measurements need to follow standardised protocols to allow for comparison across locations and time points. Furthermore, the data has to be interpreted in categories that are meaningful to citizens—and not only graphically.

Our initial experiments taught us that to be of any value and to get the measurements right, citizen science projects must adhere to proper scientific principles and procedures. This requires the use of sophisticated AI techniques to bridge the gap between scientists, experienced in physical measurement, and citizens dealing with signal processing, detection of patterns, categorization of data, prediction of future data based on simulation, and data visualization. Because attempts to secure European project funding to carry out the foundational research and scale up testing failed, the efforts at Sony CSL Paris and its various partners—experts in local air simulation, sensor technology, measurement strategies, etc.—were put on hold.

"CITIZEN SCIENCE PROJECTS MUST ADHERE TO PROPER SCIENTIFIC PRINCIPLES AND PROCEDURES."

A decade later, the dream of participatory sensing using mobile devices remains largely a dream, even though the technological resources for participatory sensing (for example, the availability of sensors or AI systems for analysis and prediction-making) have improved, and Fab Labs have made it possible to release designs in open source for digital fabrication. One of the best-known examples is the Smart Citizen kit, which was developed by Fab Lab Barcelona in cooperation with De Waag Society in Amsterdam. The specifications of the device, as detailed on their website (https://smartcitizen.me/about#hardware) are as follows: "The Smart Citizen Kit is a piece of hardware comprised of a sensor and a data-processing board, a battery and an enclosure. The first board carries sensors that measure air composition (CO and NO_2), temperature, humidity, light intensity and sound levels. Once it's set up, the device will stream data measured by the sensors over Wi-Fi using the FCC-certified, wireless module on the data-processing board. The device's low power

"THE DREAM OF PARTICIPATORY SENSING USING MOBILE DEVICES REMAINS LARGELY A DREAM."

"FAB LABS HAVE MADE IT POSSIBLE TO RELEASE DESIGNS IN OPEN SOURCE FOR DIGITAL FABRICATION."

consumption allows for placing it on balconies and window-sills. Power to the device can be provided by a solar panel and/or battery. The Kit is not another black box compatible with Arduino." The major step forward lay in the relative ease of fabrication. All the design files are open-source (schematics and firmware) and can be produced digitally and simply assembled.

Unfortunately, testing in real world circumstances showed that the Citizen Science Kit did not fare better than the phone-based air quality assessments like the ones we carried out in Paris. (See the evaluation report by van den Horn and Boonstra, 2014). The NO_2 sensor turned out to be unusable in outdoor environments, and similar problems plagued sensor calibration, data interpretation, measurement protocols, etc. Many participants reported having had trouble connecting their kit or making it work reliably. Nevertheless, the project again underscored citizen's enthusiasm and eagerness to take part in measuring their environment. Participants reported a very strong uptick in their willingness to hold governments and official institutions to account.

Do the difficulties of these prototype experiments mean that the dream of empowering citizens to tackle pollution in their urban environment through participatory sensing should be abandoned? Certainly not.

First of all, the experiments described above demonstrate that achieving this goal will require a much more thorough scientific approach; the collaboration of official institutions tasked with measuring air pollution; as well as more sophisticated technology, particularly AI, to bridge the gap between expert knowledge and citizen action. This of course means securing more funding, and the past decade has repeatedly shown just how hard getting such funding can prove. There are also other aspects of air pollution that can be measured. Take, for example, a very successful, on-going project measuring fine particles: It's based on attaching an add-on in front of the smartphone camera that transforms it into an optical sensor, suited for measuring the macro- and microphysical properties of atmospheric aerosols. The add-on measures the (intensity)

"DO THE DIFFICULTIES OF THESE PROTOTYPE EXPERIMENTS MEAN THAT THE DREAM OF EMPOWERING CITIZENS TO TACKLE POLLUTION IN THEIR URBAN ENVIRONMENT THROUGH PARTICIPATO-RY SENSING SHOULD BE ABANDONED? CERTAINLY NOT."

spectrum and the degree of polarization for visible light (Snik *et al.*, 2014).

Secondly, there are now a number of projects in participatory sensing of NO_2 air pollution that have been successful, although they no longer use mobile phones or special kits but rather more traditional means. One is a Belgian/Flemish project "CurieuzeNeuzen," or "Curious Noses," (https://curieuzeneuzen.be/) established by official institutions dealing with air pollution in collaboration with environmental scientists of Antwerp University and the Flemish Institute for Technological Research, experts in air quality measurement and environmental simulation. A pilot project involving 2,000 citizens took place in 2016 in the city of Antwerp, and a more extensive project involving 20,000 citizens (selected out of around 50,000 volunteers) was completed in May, 2018. The high levels of public interest and participation resulted from a finely tuned media campaign, as well as the decision to mark measuring points very visibly. A similar smaller-scale project took place in Brussels in May, 2018, and the results, particularly near schools, were so disturbing that they triggered outrage and protests among teachers, parents, and even the schoolchildren themselves.

"THE IMPACT CLEARLY DEMONSTRATED THE KIND OF EFFECT PARTICIPATORY SENSING CAN HAVE, TOUCHING OFF CITIZEN DEMANDS FOR GOVERNMENT ACTION."

In the Belgian projects, participants "installed a simple, standardized measurement device on a street-facing window of their house, apartment or building. Two diffusion tubes determine the mean concentration of nitrogen dioxide in the ambient air over one month. The samplers are attached to a V-shaped window sign commonly used in advertising real estate in order to establish a standardized measurement setup. The data collected from the diffusion samplers are quality controlled and calibrated with NO_2 measurements at reference monitoring stations operated by the Flemish Environment Agency." (https://curieuzeneuzen.be/) Data was centrally extracted from the tubes, aggregated, and visualized, and the results were then made public. The impact clearly demonstrated the kind of effect participatory sensing can have, touching off citizen demands for government action.

Participatory sensing of air pollution

Finally, participatory sensing using mobile phones has proven quite successful for noise pollution monitoring—another major citizen concern. Right after completing the air pollution experiments at Sony CSL in Paris in 2007, I started working with Matthias Stevens, Nicolas Maisonneuve, and Peter Hanappe on another approach—namely, to use phones as mobile sensors for noise (Maisonneuve *et al.,* 2009). Given that phones already have built-in microphones, this seemed like a natural focus. Nevertheless, once again it quickly became clear that you could not simply feed the recorded sound into signal processing algorithms to determine exposure to noise because sound processing in phones is highly optimized for human speech. But still, such hurdles proved easier to overcome than the technical obstacles for air pollution.

A system, called NoiseTube, was launched in 2008, in the form of a freely downloadable app and various web-based visualisation tools. Around 2010, the NoiseTube project moved to the VUB Artificial Intelligence Laboratory (Stevens, 2012) and later to the VUB Software Programming Group, where physicist Ellie D'Hondt further fine-tuned the quality of the measurement to make it scientifically adequate. The NoiseTube system was progressively extended to contain other tools one would expect for a community memory, such as social tagging, collective city-wide noise maps, AI-based sound classification, tools for feedback and opinion exchange, mechanisms for securing users' data privacy, and the inclusion of volunteer distributed computing (D'Hondt *et al.*, 2012).

Around the same time, the NoiseTube system became part of a large-scale project set up by Catherine Lavendier, of the University of Cergy-Pontoise, that brought together the official organisation for monitoring noise pollution in Paris, Bruitparif, and the city of Paris. This project also has been able to prove that when done properly, participatory sensing can achieve similar levels of accuracy to the "official" scientific instruments.

"PARTICIPATORY SENSING CAN ACHIEVE SIMILAR LEVELS OF ACCURACY TO THE "OFFICIAL" SCIENTIFIC INSTRUMENTS."

Conclusions

AI methods and techniques are very relevant to the goals of the Fab Lab network. They can partly help to make tasks like design and the programming of machine tools more doable for less-experienced citizens and can also play a major role in setting up a community memory—an information resource where citizens can upload data, comments, opinions, and knowledge in order to manage and define their commons. I focused here on examples from the domain of air and noise pollution, although this approach also has wider applications. AI can play a role in interpreting sensors; for prediction aimed at improving sensory interpretation or informing the community about the future state of their commons; for finding patterns in data; for structuring and querying based on social tags; as well as other applications. Much work remains to be done, but there is a sense of urgency, informed by a need to act before the environment is irredeemably destroyed.

“AI CAN PLAY A ROLE IN INTERPRETING SENSORS; FOR PREDICTION AIMED AT IMPROVING SENSORY INTERPRETATION OR INFORMING THE COMMUNITY ABOUT THE FUTURE STATE OF THEIR COMMONS; FOR FINDING PATTERNS IN DATA, AND FOR STRUCTURING AND QUERYING BASED ON SOCIAL TAGS.”

DECOLONIZING DIGITAL FABRICATION

RON EGLASH

"FROM HERITAGE ALGORITHMS FOR STEM EDUCATION TO SOLAR INK FOR WEST AFRICAN FABRICS, GENERATIVE JUSTICE CAN GUIDE US, BOTTOM-UP, TOWARDS A JUST AND SUSTAINABLE FUTURE."

Why do pressing social problems—environmental degradation, labor insecurity, ethnic and gender inequality, and so on—look so much alike in both capitalist and communist societies? Systems designed to extract value—whether that value is delivered to private corporations or centralized states—are inherently flawed: Once value has been alienated, it's nearly impossible to restore. But defining what it means to nurture value mobility in unalienated form—circulated rather than extracted—is by no means obvious. By collaborating with indigenous communities, urban artisans and others, our research group has explored "generative justice" as both theoretical framework and experimental intervention. Here we report on our results with computational, thermal, and mechanical systems that expand the circulation of unalienated value in three domains: labor value, ecological value, and expressive value. From heritage algorithms for STEM education to solar ink for West African fabrics, generative justice can guide us, bottom-up, towards a just and sustainable future.

Introduction

"THE FAB CITY INTERNATIONAL INITIATIVE REPRESENTS AN EXCITING CALL TO MOVE TOWARDS A JUST AND SUSTAINABLE FUTURE."

"IT'S IMPOSSIBLE NOT TO HEAR ECHOES FROM THE COLONIAL PAST."

The Fab City international initiative represents an exciting call to move towards a just and sustainable future. At the same time, it's impossible not to hear echoes from the colonial past. The Gershenfeld brothers' recent Fab Lab manifesto is entitled Designing Reality, and it would be hard to imagine a name that would more vividly invokes a "Masters of the Universe" vibe. The word "universal" occurs 47 times in the book, usually describing the importance of standardizing a single universal set of machine communications across the globe. The colonial undertones are not restricted to the metaphorical realm: In light of the fact that Chevron Corporation's activities have caused billions of dollars in environmental damage in Ecuador, Brazil, Angola, Nigeria, and elsewhere, what should we make of their $10 million dollar donation to Fab Labs? How might the $2.8 million in Fab Foundation funding from the Department of Defense diminish the network's educational efforts and activism aimed at fabricating products and promoting practices that oppose the U.S. military's hyper-inflated budgets, saber-rattling aggression, slick youth marketing, and covert drone killings?

To clarify: I'm a firm believer in the Fab City vision and an enormous fan of the Gershenfeld brothers' work. Neil's focus

on "generative design" puts his finger squarely on the crux of the issues. Joel's brilliant analysis of the contributions that unionized workers made to the resurgence of the U.S. auto industry (Cutcher-Gershenfeld *et al.,* 2015) is a firm rebuke to anyone who suspects that Fab Labs are an anti-labor conspiracy. Alan's role in the acclaimed Iñupiaq game Never Alone represented a breakthrough in replacing the thin ethnic veneer so commonly masquerading as "inclusion" in digital media with a deep collaboration that included native writers, artists, elders, and the first indigenous-owned game developer and publisher. But if Fab Cities are to achieve their goals, we cannot afford to be naïve about the lengths to which multinational corporate giants and militant nationalism will go to hold onto power.

One might be tempted to think that if the problem is corporate power, then Marx's communist framework could represent be the solution. But the history of state communism—from Stalin to the Stazi; Ho Chi Minh to Hugo Chavez—has been unrelentingly bleak. Marx and Engels set the tone in 1850: "A revolution is certainly the most authoritarian thing there is... and if the victorious party does not want to have fought in vain, it must maintain this rule by means of the terror which its arms inspire in the reactionaries." Replacing the corrupting force of banks, corporations and Wall Street greed with central planning, secret police, and state bureaucracy creates no change at all.

Where did Marx go wrong? His initial concept was sound. In his 1844 "comment on James Mill," Marx includes a portrait of a traditional, pre-capitalist village artisan: a woman whose pride is derived from the fruits of her labor, and whose feeling of belonging comes from being enmeshed in a rich social network of exchange. In his later "Ethnological Notebooks" Marx showed particular interest in the descriptions of Iroquois life, as related by anthropologist Lewis Morgan, whose work shed a great deal of light on their communal sharing and gender-egalitarian relations.

"WHERE DID MARX GO WRONG? HIS INITIAL CONCEPT WAS SOUND. WE MOVE FROM HOMO FARBER, MAN THE MAKER, TO HOMO EMPTOR, MAN THE SHOPPER."

When Marx contrasts these traditional ways of life with the scene within a capitalist factory, we see immediately how labor has become alienated from workers. There's no pride of craft in simply turning the same bolt on an assembly line all day long, and little source of identity or social connection, either. A bit of the value that's extracted from these factory workers is returned in the form of wages, and so they attempt to fill the hole in their lives through consumption: We move

from Homo Farber, man the maker, to Homo Emptor, man the shopper. At first only the means of production was transformed to maximize capitalism, but once commodities become our identity, "subsumption" takes over, and all social functions are sucked in. Our relations with people, nature, built environments, religion—all become transactional.

"THE MISPLACED OPTIMISM THAT A CENTRALIZED BUREAUCRACY, RUN BY ELITES, WOULD KNOW HOW TO MAKE WORKING CLASS ENVIRONMENTS EMPOWERED AND ENJOYABLE SEEMS NAÏVE IN RETROSPECT."

Marx mistakenly believed that the problem was not extraction, but rather the fact that the value begotten from extraction was delivered to capital. He proposed that a communist state could gather this extracted value and redistribute it, according to needs of the people. But it turns out that mindless bolt turning in "the people's factory" isn't any more enjoyable (Burawoy, 1985). The misplaced optimism that a centralized bureaucracy, run by elites, would know how to make working class environments empowered and enjoyable seems naïve in retrospect. But Marx felt he had no choice: In the absence of value extraction by a centralized state, the only alternative to capitalism would be indigenous life in the village, teetering on the verge of starvation and perennially unable to rise beyond what he called "nature's paltriness" (natur-bedurftigkeit).

Despite his radical political stance, Marx held a colonial, hierarchical view of cultural that placed Europeans at the top. Marx was not only wrong about the health implications of indigenous economies—their dietary habits were often far better than Europe's penchant for fat, sugar and white flour—but also about their relation to nature. The centralized communist economy—armed with the latest science and technology and organized for "winning a war against nature"—led to massive desertification. The indigenous herders on the other side of the border, on the other hand, prevented a "tragedy of the commons" by relying on centuries-old collaborative relations that circulated value in unalienated form—milk, dung, brush reduction, sacred ritual, crafted artifacts and so on—among one another and with their fellow non-humans in the local ecosystems.

"LEAVING VALUE IN ITS UNALIENATED FORM AND ALLOWING IT TO CIRCULATE IN A COMMONS, AS WAS DONE IN THE INDIGENOUS TRADITION, IS ACTUALLY FAR BETTER FOR BOTH PEOPLE AND THE PLANET."

Thus Marx's error was assuming that the only way to meet modern needs in health and human services was to require that both labor value and ecological value be alienated, extracted, and centrally redistributed. On the contrary, leaving value in its unalienated form and allowing it to circulate in a commons, as was done in the indigenous tradition, is actually far better for both people and the planet. This essay describes our experiments in merging these unalienated forms with Fab

Lab-style production techniques. The hybrid of the two—a sort of cyborg ecosystem—is not a "tech fix." It requires innovation in social, technical, and environmental domains, as well as the restoration of diminished histories.

Before leaving the counterexample of the USSR, it's helpful to look at a third form of value, the semiotic realms of spirituality, sexuality, media, arts, and other forms of expression. Some scandals of wanton capitalist environmental destruction in the U.S. resulted in books, like Silent Spring, and protests, like Love Canal, that ended up mitigating some of the damage. Communist suppression of human expression not only created a crisis in human rights, it also encouraged environmental destruction by suppressing public scrutiny. Bottom-up liberation of expressive value is just as crucial as the emancipation of labor and the flourishing of nature's non-humans.

Thus, the fundamental principles of generative justice extend across all value forms, with a particular focus on labor value, ecological value, and expressive value. They are:

The universal right to generate unalienated value and directly participate in its benefits; the rights of value generators to create their own conditions of production; and the rights of communities of value generation to nurture self-sustaining paths for its circulation.

Ethnocomputing and generative justice

Applying generative justice to Fab Labs means that contemporary fabrication techniques are facilitating, nurturing, or extending the ways in which labor value, ecological value, and expressive value are able to circulate in unalienated form. Elsewhere (Bennett, 2016; Eglash, 2016a, 2016b; Kuhn, 2016; Lokko and Eglash, 2017; Lachney, 2018) we have reviewed these concepts in greater detail, but due to space constraints, a few words will have to suffice here.

At its core, the word "generative" in the term "generative justice" refers to a self-generating system. Neil Gershenfeld provides wonderful insights on precisely this recursion in chapter 3 of Designing Reality, describing life as self-evolving and humans as self-aware—hence, the need to establish Fab Labs in the near future on the basis of a self-assembling process he calls "generative design." But he misses an opportunity when celebrating John von Neumann as the father of

"THE UNIVERSAL RIGHT TO GENERATE UNALIENATED VALUE AND DIRECTLY PARTICIPATE IN ITS BENEFITS."

"THE RIGHTS OF VALUE GENERATORS TO CREATE THEIR OWN CONDITIONS OF PRODUCTION."

"THE RIGHTS OF COMMUNITIES OF VALUE GENERATION TO NURTURE SELF-SUSTAINING PATHS FOR ITS CIRCULATION."

"APPLYING GENERATIVE JUSTICE TO FAB LABS MEANS THAT CONTEMPORARY FABRICATION TECHNIQUES ARE ABLE TO CIRCULATE IN UNALIENATED FORM."

self-reproducing automata, stating that it was simply because von Neumann was "interested in understanding life."

Heims (1980) details how von Neumann's precarious survival as a young Hungarian Jew evolved into a lifelong quest for imposing mathematical order on the world. He invented game theory to prove that politics was a zero-sum competition, and his work on the Manhattan project—where it was his calculations that showed how to create fission by implosions, and his calculations for maximizing civilian casualties that determined the locations and altitudes for Hiroshima and Nagasaki explosions—led von Neumann to call for an immediate nuclear first-strike against the USSR during the cold war. "If you say why not bomb [the Soviets] tomorrow, I say, why not today? If you say today at five o'clock, I say why not one o'clock?" (Heims, p. 247). During the Hixon symposium (Jeffress, 1951) he stated that in the event of "air raids," "there is no doubt that one can design machines which, under suitable circumstances, will repair themselves." It doesn't take much to see that von Neumann likely considered how his self-reproducing mechanical progeny would populate the earth after humans were wiped out by radiation. He died relatively young age, of a cancer that had almost certainly resulted from his proximity to the nuclear test explosions he loved attending. Neil is wrong when he states that von Neumann took the path to self-reproducing automata because of an interest in life: On the contrary, it was being a merchant of death that drove him there.

"A FAR BETTER CONNECTION BETWEEN ALGORITHMS, SOCIAL JUSTICE AND SUSTAINABILITY CAN BE FOUND IN VARIOUS INDIGENOUS TRADITIONS AROUND THE WORLD, RATHER THAN IN COMPUTATIONAL SYSTEMS."

Therefore, it follows that if we are in search of a guide on how to keep the value generated by labor, ecosystems, and expression from becoming extracted, and to use computational systems to nurture its circulation in lively, unalienated forms, grim reapers like von Neumann are the last place we should be looking for inspiration. A far better connection between algorithms, social justice and sustainability can be found in various indigenous traditions around the world. For example, in the late 1980s, I observed that aerial photos of African villages looked like fractals: rectangular houses were in nested rectangles-within-rectangles; circular houses in circles of circles, and so on (figure 1). A Fulbright scholarship allowed me to travel around Africa conducting interviews, and I gradually accumulated a casebook of the fractal designs in native textiles, sculptures, adornment and other material forms; as well as in their recursive cosmologies and underlying social mechanisms (Eglash, 1999). In the Ba-ila simulation, we start with a single house and its sacred altar near the

back. In the next iteration, the self-replicating line representing the altar becomes the human habitation towards the back of the corral; in the next iteration that becomes the chief's extended family compound; within that, the immediate family, and within that, a village that is only a meter across; it holds the ancestors, who have further recursions in their own realm.

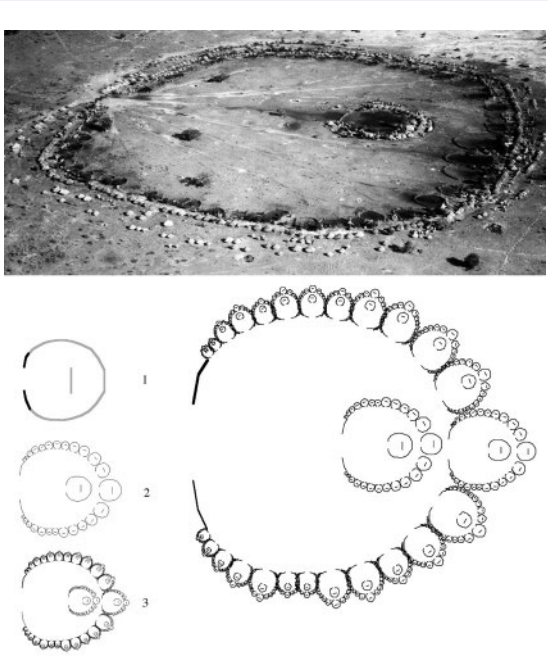


Figure 1: Traditional Ba-ila architecture and its fractal simulation.

Such representations of the generative power of life are commonly found at the heart of African fractals—whether in sculptures, reminding us of our feedback loops with nature; textiles, as the emergent effects of networks of sociality; or built environments, celebrating ancestral bonds. Take, for example, the difference between my small house and the New York governor's gigantic mansion. It's hard to even put them in the same class of structures; the differences are meant to reinforce our difference in social class. The self-similarity of African architecture, in contrast, ensures that the chief's home is essentially just a slightly larger version of the commoner's homes. The fabrication of artifacts also helps reinforce egalitarian relations. Hunter-gatherer groups in the Kalahari Desert, for example, use the hxaro gift exchange system, which stipulates that meat belongs to the maker of the arrow, not the one who shot it. That means that even those who don't hunt—women, elders, and people with disabilities—can still "bring down game" (although that also comes with the responsibility of "gifting" meat to others).

Inspired by the African fractal tradition, architect Xavier Vilalta created two contemporary fractal buildings in Ethiopia in 2013. A new school vocational school, the Melaku Center, used fractal layouts to create clusters of clusters of buildings, allowing for a more humane, more welcoming campus, with nooks and crannies that can be used as spontaneous meeting places, outdoor spaces for workshops, and microenviron-

ments for plants. A shopping center in Addis Ababa used fractal perforations on the exterior walls, creating a breathable "skin" that reduces the energy needs. And a fractal array of solar cells on the rooftop turns a potentially alienating space into a pleasant outdoor market, generating enough electricity to keep the building powered during blackouts, thus making it more attractive to local merchants. Other applications for African fractals have been showing up in Afrofuturist fashions, arts, and even black literature like Nnedi Okorafor's Binti and Erna Brodber's Nothing's Mat.

Perhaps the most important applications of this "ethnocomputing" approach are to be found in education. We created a suite of these simulations, "Culturally Situated Design Tools," (CSDTs: open access at http://csdt.rpi.edu) which include not only African fractals but also native American weaving algorithms, Latino drum cycle ratios, urban graffiti curves, and so on. In each case, we began by working with tribal elders, community activists, and others to ensure that we made respectful use of the materials; tapped into authentic, unalienated aspects of the practices; and that we were not imposing our own computational or mathematical ideas on their indigenous knowledge. Using controlled studies in which one group of students use typical classroom methods, and the others learn math, computing and other STEM topics by creating designs with these "heritage algorithms," we found a statistically significant improvement for the culture-based group (Eglash *et al.,* 2011; Babbitt *et al.,* 2015; see https://csdt.rpi.edu/publications for a full list).

The scripting interface for CSDTs looks a lot like MIT's Scratch (and, indeed, we share the same codebase, Google's "blockly"). But there is a huge difference. Our research of youth-uploaded projects on the Scratch community (Lachney *et al.* 2016) showed an overwhelming presence of animations, art, games, music, and stories featuring commodities: 2,960 results for Barbie; 6,530 results for McDonald's; 4,600 for Disney Princess; 8,210 for Transformers; 17,400 results for Call of Duty; as well as numerous others, such as Bratz, American Girl, Strawberry Shortcake, Power Rangers, Care Bears, My Little Pony, Adidas, and Pokemon, which garnered 3 million search hits. The Scratch motto, "We turn children from consumers into producers," seems oblivious to how thoroughly corporations have colonized childhood.

The alternative is not censorship, arm-twisting, or didactic preaching. Rather, we simply start students off with rich cultural connections. Where they take it from there is up to them. On some rare occasions, we've seen students using CSDTs make commercial references—something along the lines of turning a West African adinkra curve into a Nike "swoosh." But that simply confirms that the system is open enough to avoid being censorious. More commonly, we see users creating cultural hybrids: African American students using the native bead loom CSDT to create graffiti tags; Latino students using graffiti curves to create symbols from Mexico; and so on. One Navajo student, looking at beadwork simulations, spotted a Jamaican flag design, created by an African American student whose parents hailed from the Caribbean. The Navajo student then made her own rug simulation that incorporated Navajo aesthetics. Black students simulating quilts often remark upon our section of white Appalachian quilts, where they find the "radical rose" pattern used in auctions to raise money for the abolitionist cause during the Civil War—a discovery that challenges their assumptions about white working class history. Far from static forms of "identity politics," cultural algorithms can encourage cross-cultural connections. Rather than being content-agnostic, we need these kinds of "content aware" systems as a means of facilitating paths for generative flow from the bottom-up.

"THE ALTERNATIVE IS NOT CENSORSHIP, ARM-TWISTING, OR DIDACTIC PREACHING."

"WE SIMPLY START STUDENTS OFF WITH RICH CULTURAL CONNECTIONS."

In sum, we needn't think of "unalienated" as a synonym for "natural" or "pure" or "simple". Appeals to what is "natural" are often harbingers of homophobia, just as calls for "purity" rarely end well. It is only modern agriculture that insists on reducing soil to simplicity. Indigenous agroecology is deeply complex and innovative. Indigenous algorithms can be unleashed in ways that expand their reach, while at the same time retain their power to regenerate communities of origin. But how do we route this flow through the networks like Fab Cities?

"INDIGENOUS ALGORITHMS CAN BE UNLEASHED IN WAYS THAT EXPAND THEIR REACH, WHILE AT THE SAME TIME RETAIN THEIR POWER TO REGENERATE COMMUNITIES OF ORIGIN. "

Fabricating with Generative Justice

One of the unfortunate tendencies in digital fabrication is to approach the process similar to a kind of universal digestive acid: it eats everything, shits out 1s and 0s, and reconstitutes them, as either homogeneous blobs of plastic or laser cuts, that are oblivious to whether they're slicing through birch

or butter. In contrast, while working with Native American artisans, we noticed their remarkable attention to material microstructure, especially in wood. One Athabascan group was able to distinguish between wood from northern and southern sides of the same tree, based on its hardness. Much of our work was carried out with Anishinaabe collaborators (a group which includes the Ojibwa, Potawatomi, Algonquin, and several other Northeastern nations). They made detailed observations about annual rainfall and its effects, noting that tree harvests (in this case, creating strips of bark for lashings) would need to be done closer to the stream than usual because it had been a dry year, thus affecting pliability. The discussions over modulus of rupture led our Anishinaabe language teacher, Kenn Pitawanakwat, to create a new word for it, epiichiiyimigak (which toughly translates as "how much weight it can take.") As language survival is a major concern, this and other terms have been recorded and can be heard on the CSDT for this activity: https://csdt.rpi.edu/culture/anishinaabearcs/materials.html.

"A GENERATIVE APPROACH TO FAB CITIES WILL REQUIRE THE SAME KIND OF DEDICATION TO EGALITARIAN RELATIONS WITH BOTH HUMAN AND NON-HUMAN ALLIES THAT THE ANISHINABE HAVE MAPPED SO WELL."

It is crucial to understand that these "translations" to Western science are always in some way incomplete. For example, the understanding that trees have "personhood" (Naagidewn-jigon) helps ensure ecologically sustainable harvesting (for example, limiting the harvests to a single branch allows the tree to continue to grow; removing one sapling makes room for others to grow larger.) That personhood is also closely tied to these mechanical properties in complex ways. One can be an atheist and still understand the connections, just as one can hold spiritual commitments and still understand the science. In either case, a generative approach to Fab Cities will require the same kind of dedication to egalitarian relations with both human and non-human allies that the Anishinabe have mapped so well.

One of the heritage algorithms that emerged from this work with the Anishinaabe was the persistent use of arcs: bending wood into the ribs of canoes, snowshoes, baby carriers, and, above all, wigwams. While "arcs" might seem simplistic, wood-bending curves can be quite complex (think of the S-shape curls in Ojibwa black ash baskets). The numerical mathematics of wood bending requires Bézier curves (a way of specifying control points, where the wood is anchored, that are acted upon by "blending functions" such as Bernstein polynomials.) Wood bending can be thought of as an analog computer, creating its equations by physical instantiation.

We tend to think of mathematics as abstract equations that, once solved, can then be physically rendered as forms. But the mathematicians in this case, Pierre Bézier and Paul de Casteljau, were actually employees of French car manufacturers Renault and Citroën. Before either went to work there, the beautiful curves of these cars (who can forget the Citroën DS?) were created using wood "splines", which had been used centuries earlier to model curves for ship construction. In other words, the math first appeared in the form of wood, not equations, both the among the Anishinaabe and among Europeans. The only difference is that while the Anishinabe embrace the connection—trees have personhood and, hence, agentic knowing—Western traditions of intellectual property and egotistical competition strive to erase the connections (which is why have "Bézier curves," when Casteljau actually developed them first.)

Native students in our workshops begin by reviewing the indigenous understanding that the act of bending stores energy. In the case of bows and arrows, or spring traps, it's released; in other cases it performs what Buckminster Fuller called "tensegrity," the structural elements pushing against each other to fill out and stabilize a form. Following the review, students simulate 3D wigwams, reverse-engineering the traditional algorithms by trial and error. Then they begin to creatively elaborate these designs, often ending up with something that looks nothing like the traditional form—a kind of heritage of the future. At this point, we could use a 3D printer or laser cutter, but that would destroy the intimacy with materials. Since the virtual structures all have intersections with virtual ground (thanks to their origins as wigwams), we mark those points on physical boards. A printout of the design provides a list of the required lengths, as well as their points of intersection. Therefore, the students are empowered by the translation to virtual forms, but still reap the benefits from unalienated hand-crafting. Some decide to take the technological path a step further and render designs with electroluminescent wire. Anishinaabe students further advanced their work by writing about new applications they imagined, from flexible room lights, to wigwam-like structures for Martian habitation. One theme of great interest that emerged was the greenhouse. In the next phase of this work, Anishinaabe students will design and build an aquaponics system, bringing structural design together with their "decolonizing diet" program.

A generative justice approach typically starts with a source of unalienated value, but these are easier to identify in some cases than in others. Low-income African American communities have a hair braiding tradition, and their cornrows possess extraordinary algorithmic properties. High school students again began by exploring these designs virtually, but in this case they splintered off into several directions. One group used 3D printers to create custom mannequin heads that were installed in local salons in a bid to attract more customers. Another group explored the pH of hair products using Arduino-based sensors, which allow them to develop and market their own natural alternatives. Other projects still in exploratory stages include a hair strength meter; laser interferometry for hair damage metrics; and the use of braiding algorithms to explore new forms of carbon fiber structures.

Our most complex example was adinkra, a West African stamped cloth tradition. Our examination revealed that adinkra symbols for living things tended to have logarithmic spirals in their structure—a wonderful connection between the exponential growth patterns, as we would refer to them in the West, and indigenous African knowledge. Ghanaian students being taught the distinction between linear and log spirals not only appeared to grasp the concept better through this model but also displayed unusual enthusiasm. (Many of the students requested to remain after school—a rarity in the math class.) We discovered that the ink used to make the stamped patterns was derived from tree bark, and that places in which the bark was harvested were not being deforestated. And because the traditional method of boiling bark down to ink generally consumes prodigious amounts of firewood, we proposed a solar alternative. Adinkra symbols also conveyed understandings of health and well-being and were, therefore, an obvious choice for graphic elements in an HIV program. That lead to the development of a DIY condom vending machine, with some parts recovered from electronic waste dumps. Further experiments included using physical scripting blocks, together with miniature stamps, so that students without computers could still learn about algorithms. The network as a whole shows how value can circulate through many different forms while retaining a relatively unalienated character.

Adinkra symbols have also been used in a Batik process in Ghana. The Global Mamas clothing line, which caters to an international clientele, trains local women to carve latex foam into wax stamps. However the latex wears out, and because

it's not biodegradable, a noxious pile of synthetic foam bricks has accumulated. We originally approached them about using the CSDT simulations to add an additional skill-set to local training, with the idea that laser cutting foam would nicely link the virtual and physical designs without affecting the hand-stamped character of the product. But concerns about waste send us back to the drawing board. Figure 2 shows our modified process. The artisans start with an adinkra simulation, in this case, Dwennimmen, the ram's horns (which is yet another lovely case of log spirals). There's a saying associated with this symbol: "It is the heart and not the horns that led the ram to bully," which in contemporary parlance might be taken to mean something along the lines of "just because you are a tech genius does not mean you are relieved of accountability for your impact on the world." The next step prints a 3D mold of the form, which we fill with a mix of fungus spores and sawdust (the creation of a company started by our students here at RPI, Ecovative). Once fully-grown, the stamp can be used just like latex, but has the distinct advantage of being biodegradable.

"JUST BECAUSE YOU ARE A TECH GENIUS DOES NOT MEAN YOU ARE RELIEVED OF ACCOUNT-ABILITY FOR YOUR IMPACT ON THE WORLD."

Pathways to generative fabrication

Indigenous contexts are not the only places where it's possible to bring fabrication techniques and generative justice together. Open source can be thought of as an example of generative justice: its code often leans toward less alienated forms of production, (for reasons more complex than we can describe here; see Eglash and Garvey 2014) and its value is circulated in a commons. Open source models have moved beyond software; they now include open source pharmaceutical research; open media; architectural blueprints; and so on—constituting every bit as as much a "commons" as any indigenous village's pooled resources. Figure 2 shows a value flow network for Arduino, the world's most popular open source microprocessor. It's no coincidence that Arduino was born in Northern Italy, an area of a rich design tradition that economists Piore and Sabel (1984) identified as a center of the rise of "flexible economic networks." (Olivetti typewriters, for example, used to be based in the same city where Arduino is now). Just as African culture can contribute fractals in generative circulations, the traditions of Northern Italy's contributed to the rise of Arduino. In the diagram above, I mapped alienated value flow using single lines and unalienated with double lines.

"JUST AS AFRICAN CULTURE CAN CONTRIBUTE FRACTALS IN GENERATIVE CIRCULATIONS, THE TRADITIONS OF NORTHERN ITALY'S CONTRIBUTED TO THE RISE OF ARDUINO."

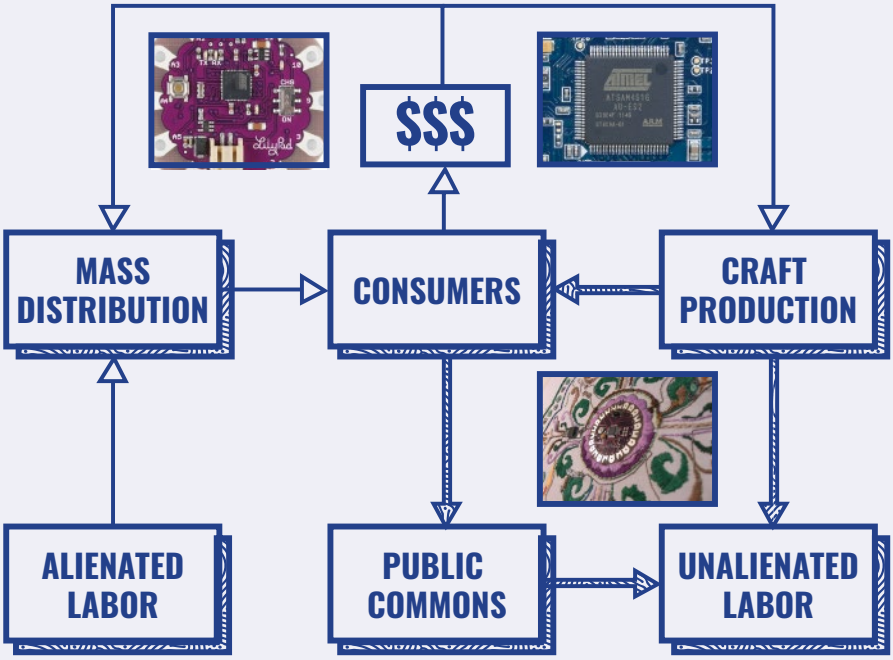


Figure 2: Alienated flow to LilyPad Arduino at left; unalienated at lower right; hybrid at upper right.

The upper left quadrant shows the chips making up Arduinos, still sourced from relatively alienating factory conditions. The lower right shows the commons-based "peer production" of lay people's craft: for the most part free from alienation, but also free from income. The critical intersection in the system is the upper right: in this case I showed the LilyPad Arduino created by Leah Buechley. Because the Arduino hardware is open source, Buechley was able to redesign it in a form that is more amenable to e-textiles. Her study showed greater numbers of female purchasers of her version of the board, (Buechly and Hill, 2010) and it's here that the system gains the most "traction," as it has one foot in the non-profit world of communal sharing, and the other foot in the for-profit (albeit still open source) world of entrepreneurship. The more the right side can be expanded, and the left diminished, the closer we move toward generative justice.

Our team has found that this analysis is generally applicable in many different domains. It's particularly illuminating to examine the lower right quadrant: a "spiritual commons" of shared belief. The pre-existing commons is always a fundamental engine for these systems, but they are not always obvious.

The root and the water

In describing the process for connecting digital fabrication to unalienated value, we often use the metaphor of root and water. The temptation for engineers is to ask for a list of problems they can solve, but such an approach is rarely helpful in expanding creative visions. "Problems" are already understood in terms of existing technological frames. "We need free cell phone minutes" does not create much opportunity for innovation. And proclaiming that we are here to solve your issues encourages over-promising.

A better description is that of root and water: Water gradually percolates through soil; and the root similarly gropes its way underground. Eventually the two will meet, but where, exactly, cannot be predetermined. It's a matter of each side exploring a space of possibilities; seeking promising interstices; and conducting trial and error iterations. Developing an eye for unalienated value is as crucial to the needed skill set as programming or CAD. In some cases, it's simply a matter of spotting artisanal labor—the kinds of occupations that allow capabilities and well-being to flourish. In other cases, it may be unrecognized ecological value. (The entire urban

"WATER GRADUALLY PERCOLATES THROUGH SOIL; AND THE ROOT SIMILARLY GROPES ITS WAY UNDERGROUND."

agriculture movement, for example, is largely based on seizing the long-ignored potential of vacant lots.) And expressive value can be overlooked, too. Who knew that rap music would be spun off into spoken word poetry?

"WE ARE USED TO THINKING OF THE COMMONS IN TERMS OF AN OPEN SOURCE REPOSITORY, BUT IN THE ARAVIND CASE IT WAS A KIND OF SPIRITUAL REPOSITORY."

But it is important to see the commons itself—and not just the value flowing through it—as a crucial component. We are used to thinking of the commons in terms of an open source repository, but can be also a kind of spiritual repository. Elsewhere, we've described how Vienna's love for coffee-houses was a kind of circulated value that enabled a project for the homeless; and how a fanfiction commons helped to force a switch to fair trade chocolate (Eglash, 2016a). We need Fab Labs that can be conduits for generative ecologies.

"WE CAN BEGIN TO GATHER A MORE FUNDAMENTAL VISION FOR HOW GENERATIVE JUSTICE AND HIGH-TECH FABRICATION CAN MERGE TO OFFER NEW PATHWAYS FOR JUST AND SUSTAINABLE FUTURES."

In mapping out a vision that extends Marx's concept of unalienated labor value to unalienated ecology value and unalienated expressive value, we can begin to gather a more fundamental vision for how generative justice and high-tech fabrication can merge to offer new pathways for just and sustainable futures.

IS THERE A 21ST CENTURY IDEOLOGY?

THOMAS ERMACORA

The 21st Century has thus far proven a turbulent period for global capitalism. The economic system that emerged victorious from the ideological tug-of-war of the Cold War—and widely regarded, in the aftermath of the telegenic fall of the Berlin Wall, as something akin to a panacea for the world's ills—hasn't fully delivered on its promises. Francis Fukuyama's End of History never happened.

The century started off with the spectacular 2001 burst of the dot-com bubble, and no sooner had the economy found its footing again than the 2008 subprime crisis struck, triggering the lingering malaise of the Great Recession that dragged on for the better part of a decade.

The meltdown of the financial system and spiking inequality ushered in a period of widespread mistrust of the very institutions that long made up the bedrock of contemporary capitalist societies: From governments, to corporations, to international organizations, a deep disbelief in their ability to address global issues has set in.

"THE REAL AND PRESENT DANGER OF CLIMATE CHANGE HAS RAISED THE STAKES EXPONENTIALLY."

Making matters worse, the real and present danger of climate change has raised the stakes exponentially. We've known for decades about just what a serious threat climate change represents. Already in 1973, the Club of Rome in its seminal work *The Limits of Growth* warned that business as usual could put the very existence of our species and all life on earth at risk. But our reaction over the intervening more than four decades has been tepid and, the scientific community has long insisted, grossly insufficient.

The Paris accord of 2016, in which 193 countries agreed to curb emissions, was a step in the right direction, demonstrating the potential of diplomacy and consensus. But still, such natural disasters as Hurricane Katrina, the centennial floods in Pakistan and the droughts in Syria—which many observers see as fueling the bloody conflict there—are all vivid reminders of the grossly insufficient pace of change.

"CLIMATE CHANGE COULD DRIVE AS MANY AS 300 MILLION PEOPLE OUT OF THEIR HOMES."

The drama playing out in Syria looks likely to be just the tip of the iceberg: The United Nations estimates that climate change could drive as many as 300 million people out of their homes by 2050. By way of comparison, that's close to the current population of United States.

It has been amply and pointedly demonstrated that the continuation of business as usual is putting the continuation

of life as we know it at risk. And still, our battered institutions have shown themselves to be woefully ill-equipped to deal with these challenges.

From our current vantage point, it would appear that maybe Karl Marx was right, after all: Market capitalism does seem to contain the seeds of its own destruction. But what if capitalism also held the formula for its own salvation? What if the very system that has generated inequality between the global north and south and unleashed a wholesale environmental devastation of life-threatening proportions could be recoded to put the welfare of people and the planet at its very heart?

That's the bold—but no longer unrealistic—proposition that global innovation hubs should be working on: The world of distributed everything, or "swarmonomics," is coming online at an exponential pace. Already, a host of different initiatives are exploring ways of re-engineering capitalism, global supply chains, and mass empowerment. I'd like to discuss two I've been a core player in.

The first emerged from the reach and power of one of the world's most august institutions, the Vatican....

The audacious question was: What if combining the ability to design for scale of the Silicon Valley-style start-ups and the wisdom of a millenary institution such as the Roman Catholic Church could heal the wounds of neo-liberal capitalism? Pope Francis' bold leadership proved the perfect moment to put the idea to the test, particularly in the wake of the 2015 release of his second encyclical, entitled *Laudato Si': On Care of Our Common Home*. The nearly 200-page-long document casts environmental destruction as a "sin" and calls for a "new way of thinking about human beings, life, society and our relationship with nature."

The time was ripe to bring together two of the world's most powerful drivers—Silicon Valley and the Roman Catholic Church, with its billion-strong flock—to try to find market-based solutions to the challenges enumerated in Pope Francis' encyclical. There's no reason that companies aiming to do good in the world shouldn't also be angling for huge profits. In fact, skyrocketing profits are exactly what would help strengthen the solutions that are the right ones for both

"THE CONTINUATION OF BUSINESS AS USUAL IS PUTTING THE CONTINUATION OF LIFE AS WE KNOW IT AT RISK."

"DIFFERENT INITIATIVES ARE EXPLORING WAYS OF RE-ENGINEERING CAPITALISM, GLOBAL SUPPLY CHAINS, AND MASS EMPOWERMENT."

"WHAT ABOUT COMBINING THE ABILITY TO DESIGN FOR SCALE OF SILICON VALLEY WITH THE WISDOM OF A MILLENARY INSTITUTION SUCH AS THE ROMAN CATHOLIC CHURCH."

people and the planet. By throwing its weight behind an accelerator, Silicon Valley's tried and true method of fostering start-ups, the Vatican could become a partner for the kind of deep societal shifts the pontiff has urged. Thus, the first annual Laudato Si' Challenge came to was born.

The first edition of the challenge targeted startups proposing innovative solutions in seven key areas: energy, food, water, conservation, industry and finance, urban solutions and human potential. More than 300 companies from 20 countries applied for the accelerator, which included an eight-week-long residency in Rome and a $100,000 equity investment. Nine were accepted, including a startup that transforms agricultural waste into clean cooking fuel, a scooter ride-share app and a company producing cheap, portable filters that fit over taps and make contaminated water into potable.

The 2018 edition of the Laudato Si' Challenge will focus on startups spearheading solutions on climate change and addressing the refugee crisis. The goal is that the goods, services and solutions imagined by the companies selected to participate in the accelerator impact the lives of at least 10 million forcibly displaced people by 2020.

"THE ONLY REAL GLOBAL DEVICE WE HAVE CAPABLE OF USHERING IN SUCH A CHANGE IS MARKET CAPITALISM."

In order for world's rich, developed nations to make up for the harm they've caused and prevent a global catastrophe, they need to lead the charge toward a radically update of our current systems, revolutionizing our energy supply, technology, supply chain management and wealth distribution. But neither governments nor the third sector can catalyze such a momentous shift this alone. The only real global device we have capable of ushering in such a change is market capitalism. We need many more of this type of accelerators to equip eager Millennials to use the tools of profit-driven capitalism to solve the planet's most pressing problems.

The second is the emergence of a unified maker-for-change collective focused on cities...

Thanks, in no small measure to Benjamin Barber's creation of the Global Parliament of Mayors, consensus has grown over the crucial role cities must play in forging a common route

to solving the seemingly intractable challenges that nation states have failed to address—particularly, climate change. At the same time, the pace of technology's penetration and transformation of society is so great, it has spurred renewed interest more citizen-centric Smart City initiatives.

How 'makers' are keeping it local

When the Maker Movement burst onto the scene at the dawn of this century, it was widely seen as a DIY phenomenon that brought bricolage into digital age, providing enthusiasts access, in so-called Fab Labs, access to 3D printers, laser and vinyl cutters, computer numerical control, or CNC mills, and other similar machines.

Over the past decade, though, the Movement has morphed into a global ecosystem for prototyping software-hardware integration. What used to be an informal testing ground for advanced production methods is rapidly becoming the place where next-generation technologists—who can both code and build sophisticated electronics—are honing their skills: Going forward, Fab Labs will be the spaces where everything from the Internet of Things to renewable-energy power stations are conceived, refined and pushed forward.

This shift in the essence of the Maker Movement is very significant, given the lightning speed with which the versioning of technology now moves and the critical role that the ability to beta test and develop new tools plays in the flowering of competitive markets. Through its unorthodox "geek houses," the Maker Movement has become a key partner in the Fourth Industrial Revolution, helping propel both the digital fabrication industries and the wider digital economy forward. The Movement has also helping counteract widespread urban decline, bringing state-of-the art manufacturing back to the very city centers from which industry fled a half century ago and offering citizens the novel chance to make the items they consume in situ. Not only is on-site manufacturing an effective way of cutting down products' carbon footprint—much of which results not from making stuff but rather from shipping it—it's also a way of building enduring employment opportunities and giving resident the skills for success in the Fourth Industrial Revolution.

"THE MAKER MOVEMENT HAS BECOME A KEY PARTNER IN THE FOURTH INDUSTRIAL REVOLUTION."

"NOT ONLY IS ON-SITE MANUFACTURING AN EFFECTIVE WAY OF CUTTING DOWN PRODUCTS' CARBON FOOTPRINT."

Multiplying maker districts and the example of London…

London's Maker Mile represents an interesting case study in the power unleashed when the maker community joins forces in service of its local community. It's a creative cluster of fabricators, studios and workshops in east London, all located within a one-mile radius. Spearheaded by the Machines Room, the UK's first Fab Lab, the maker spaces of London's Maker Mile have been working on collaborative prototypes aimed at analysing local inflows and outflows and streamlining the delivery of services to residents.

Opendesk[1] is an example of one of the Maker Mile supported startups, an online furniture purveyor that uses open-source design and manufacturing to circumvent the dysfunctional global supply chain. Opendesk allows customers to select furniture via an online catalogue and matches them with a local lab in there own city where their design can be 3D printed, thus cutting most of the costly and highly polluting logistical link out of the supply chain.

The Fab City Global Initiative shows how cities, working in concert with local communities and global business partners, can blueprint the next generation of nimble and reactive public service solutions; provide residents with the skill-set to succeed in the Fourth Industrial Revolution; attract business clusters to raise general competitiveness and build urban resilience and, in time, reduce environmental footprints. Indeed, although these are still early days in the Fourth Industrial Revolution, the Fab City Global Initiative offers an opportunity to get in on the ground floor of the movement that is spearheading the shift to a circular economy and more resilient communities.

1 https://www.opendesk.cc

THE SCIENCE OF MAKING SELF-SUFFICIENT CITIES

VICENTE GUALLART

2017 marks the 150th anniversary of the publication of the General Theory of Urbanization by the engineer Ildefons Cerdà, author of the Plan for the Reform and Extension of Barcelona. It was the first text in history to present urbanization comprehensively, as a science, and posit that it belonged among the great categories of human knowledge, apt to be included the sorts of rational descriptions that were being outlined at the time.

The technological revolution as a driving force for urban policy

"THE GENERAL THEORY OF URBANIZATION IS IMPORTANT BECAUSE IT REPRESENTED THE FIRST INTERNATIONALLY PUBLISHED ATTEMPT TO CONSOLIDATE A GENERAL THEORY ON BUILDING AND CITIES."

Cerdà has been studied in detail—his texts, his plan for transforming Barcelona, and his role as founder of the discipline of urbanism having attracted significant scholarly attention. But very rarely has his work been examined through the prism of the technical and social debates that were taking place during his time. Because he wore different hats—as a designer, as a theoretician, and as a manager—his best writings are scattered among different documents, written over the course of a 20-year period (from the memorandum of the preliminary plan for Barcelona's extension to the letters dating from his later years). The *General Theory of Urbanization* is important because it represented the first internationally published attempt to consolidate a general theory on building and cities.

Cerdà is a faithful reflection of his time, an era when the incipient effects of the Industrial Revolution were changing social, economic and cultural relationships in society. Notions about housing also had to be redefined because cities could no longer accommodate the thousands of people who were flocking in from the countryside, attracted by the new forms of industrial employment.

"THE NEW TECHNOLOGIES ASSOCIATED WITH THE ADVENT OF THE STEAM ENGINE HAD A GREAT IMPACT ON CERDÀ'S INTEREST IN THE FUTURE OF THE CITY."

In fact, the new technologies associated with the advent of the steam engine had a great impact on Cerdà's interest in the future of the city. In the introduction to his Theory, Cerdà recognizes the decisive impact of an 1844 trip he took to the French Midi, at the age of 27. He recalls already being aware of the significance of the steam engine within the fields of industry and transportation. But it was only when he experienced the railroad for the first time, and fully grasped its ability to move entire populations territories, that he realized that cities were unprepared. And with that realization came

the understanding that it was imperative to rethink how we would inhabit cities in the future.

Cerdà also mentions that he looked around for books about the effects these new technologies were having on cities, but to his surprise he discovered that nothing had yet been written on the subject. There were other urban plans for the expansion of cities, such as the plan for New York, approved in 1811, the reforms of London and Paris, and the plan for Vienna, which was in development at the time. But none of them was accompanied by a general theory.

Cerdà had an entrepreneurial spirit. Following the 1848 death of his elder brother, which made him the sole heir, Cerdà put the family's resources toward realizing his vision of expanding Barcelona and contributing to global science. It is surprising that the first draft of the preliminary project for Barcelona's Eixample was presented, through Cerdà's own initiative, to the magazine of the College of Engineers in 1856, accompanied by a small report—despite the fact that Cerdà had only been commissioned to carry out a topographical study of the area.

Throughout his career, Cerdà's ideas developed between two complementary poles: one technical, and the other social. On the one hand, as an engineer he was a techno-optimist, recognizing in science and in the new landscape ushered in by the Industrial Revolution an opportunity to improve people's lives: technology applied to mobility, housing, construction, and urban policy could be transformational, he believed. Cerdà was also an eminently practical man who based his plans on humanistic principles, aimed at achieving common welfare for all.

The social project: Urbanism or revolution

The other great debate concerning Cerdà's work has to do with the social commitment that comes through in all his work. The beginning of the Industrial Revolution touched off a widespread urbanization process that saw great numbers of people flocking to cities, drawn by the promise of jobs in industry. As many authors have written about extensively, the traditional relationship between landowners and peasants from the rural sphere and the feudal tradition was revamped into the equally hierarchical relationship between the emerging

"THROUGHOUT HIS CAREER, CERDÀ'S IDEAS DEVELOPED BETWEEN TWO COMPLEMENTARY POLES: ONE TECHNICAL, AND THE OTHER SOCIAL."

"THE BEGINNING OF THE INDUSTRIAL REVOLUTION TOUCHED OFF A WIDESPREAD URBANIZATION PROCESS THAT SAW GREAT NUMBERS OF PEOPLE FLOCKING TO CITIES, DRAWN BY THE PROMISE OF JOBS IN INDUSTRY."

"MARX AND ENGELS PUBLISHED THE COMMUNIST MANIFESTO IN 1848."

bourgeoisie and the industrial working class. These new social relationships lay at the origin of the French Revolution and social movements in the later decades, as well as the class struggle that gave rise to the Communist movement, for which Marx and Engels published the manifesto in 1848. (It's indeed a coincidence of history that Marx published his *Capital* the same year that Cerdà published the *General Theory of Urbanization*.) Some three years earlier, Engels had carried out statistical studies of the working class in London using a similar approach to the one Cerdà would later apply in Barcelona.

As asserted by many authors, Marx authored a foundational theoretical text for Materialist philosophy, economics and politics. It's a brilliant text that explains the history and internal relations of the industrial economy in order to demonstrate need for social revolution as the foundation for a new more just society. While it's a great theory, built no doubt on well-meaning hypotheses, we are all too well aware of the results of its subsequent application in various countries around the world.

"CERDÀ, BELONGED TO A SCHOOL OF THOUGHT THAT AIMED TO PUT TECHNICAL KNOWLEDGE AT THE SERVICE OF PROGRESS, FOR THE BETTERMENT OF PEOPLE'S LIVES."

Cerdà, on the other hand, belonged to a school of thought that aimed to put technical knowledge at the service of progress, for the betterment of people's lives. One of its first proponents was Henri de Saint Simon, a French philosopher and social theorist who came of age during the French Revolution whose proposals included founding a state led by scientists and industrialists as an alternative to the tradition, nobles- or church-led model. Saint Simon, along with Owen or Fourier, was later classified as a "utopian Socialist," in contrast with Marx and Engels' "scientific Socialism."

Construction of the sciences

"CHARLES DARWIN PUBLISHED ON THE ORIGIN OF SPECIES IN 1859."

Science and scientific thought as we understand it them today constitute recent phenomena, dating back to the mid-19th century. Where scientific thought had its origins in research on astronomy carried out sequentially by Copernicus, Galileo, Newton, the ideas of structuring any domain of knowledge in a global way, writing scientific treatises, aspiring to find laws and general theories were all new ones.

One of the great scientific contributions of those decades came from the naturalist field. In 1859, the same year that Cerdà published his first *Theory on the Construction of Cities*

and approved the plan for the Eixample, Charles Darwin published *On the Origin of Species*, which represented an authentic revolution in the field of science, with profound religious and existential implications. Darwin proposed the theory of evolution rooted in natural selection, meaning that a living beings' environment offers limited resources, resulting in the survival of the fittest.

Darwin's work spread quickly across Europe and found a faithful defender in the German botanist Ernst Haeckel. It was Haeckel who, in 1866, in his *Generelle Morphologie der Organismen* coined the term "ecology" from the Greek *oikos* (house) and *logos* (study or treatise). He defined ecology as "the study of all those complex interactions referred to by Darwin as the conditions of the struggle for existence."

The science of ecology, a branch of biology that studies the relationships of different living beings with each other and with their environment, has, over time, proposed a structure of knowledge similar to the ones championed by Cerdà in his Theory. In the same way that ecology analyzes ecosystems that are made up of the non-living components of the environment, the communities that integrate that environment, and the interactions of all the parts with the organisms, in the Cerdà's Theory, he examined the Container (which he defined as the physical manifestation of the city), the Content (people) and Function (essentially, the relationship between Container and Content.)

Since the mid-20th century, ecology and urbanism have begun to converge, as people began to study the impact of urban phenomena on the planet. And with climate change now being felt by people, cities, and the planet as a whole, the integration of urbanism and ecology is accelerating.

"WITH CLIMATE CHANGE NOW BEING FELT BY PEOPLE, CITIES, AND THE PLANET AS A WHOLE, THE INTEGRATION OF URBANISM AND ECOLOGY IS ACCELERATING."

The Self-Sufficient City

Everyone configures their own particular habitat through their daily actions and the resources they generate and consume, whether in an aboriginal community in the jungle, a mountain village, a neighborhood in a European city, an American suburb, or an Asian megalopolis. Each person, each community, each society, each generation throughout history has built its own habitat, aimed at serving a particular way of life. At the dawn of the 21st century, we have the unique chance of rewriting our history and the history of our urban

habitat using the knowledge and the resources at our disposal in order to produce the resources—energy, food, goods—we need to live locally.

A new human being emerges as a result of access to universal knowledge, used for individual purposes and for the good of the community. This universal knowledge allows for producing resources locally, while participating in global social networks of knowledge and economy. The strongest societies are made up of individuals with strong leadership abilities and the desire to share.

"A NEW HUMAN BEING EMERGES AS A RESULT OF ACCESS TO UNIVERSAL KNOWLEDGE, USED FOR INDIVIDUAL PURPOSES AND FOR THE GOOD OF THE COMMUNITY."

The Self-Sufficient City is an attempt to define the conditions in the urban environment that will allow the cities of the 21st century to be inhabited through networked self-sufficiency. Those conditions will make it possible for human beings to take charge of organizing their existence. The project is centered on rehumanizing cities based on efficiency in the generation and consumption of resources, as well as fostering quality of life and promoting local culture from a global technological and economic foundation. All this constitutes a new economy of urban innovation.

"WITH STRONG CITIZENS, COMES STRONG SOCIETIES."

Cities, which in recent years have obscured their obsolescence behind spectacular formal artifices, in the form of architectural icons, have the ability to rewrite their history using new principles that emerge from the distributed systems favored by the information society. This model surpasses the centralized systems of industrial societies by building new functional structures and social structures based on the relationship between multiple entities, acting as a network.

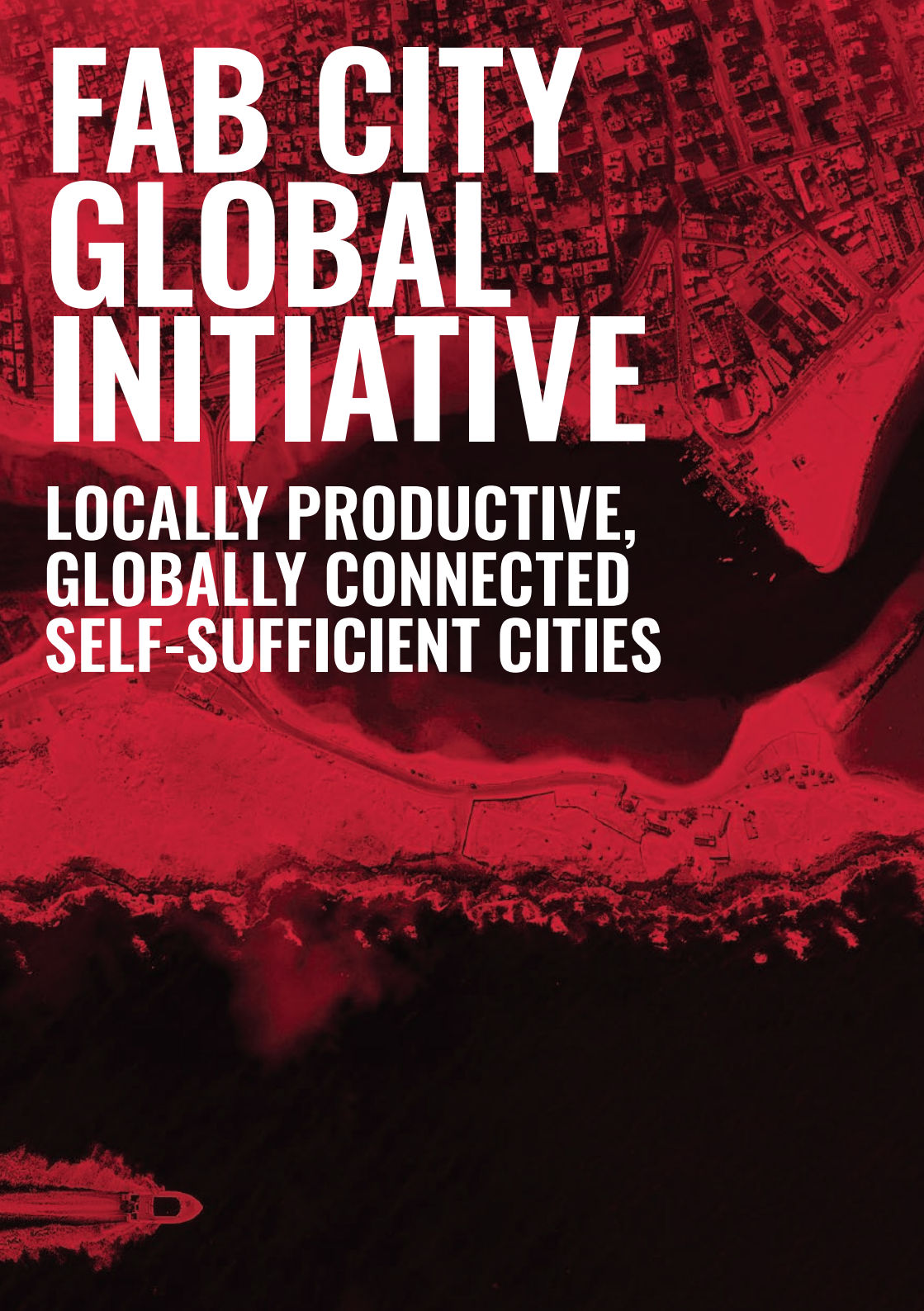
"CONNECTED SELF-SUFFICIENCY ALLOWS FOR BETTER RESISTANCE TO GLOBAL COLLAPSE."

Connected self-sufficiency allows for better resistance to global collapse. In times of crisis, like the present, guaranteeing the supply of resources and the safety of the development of urban processes is as important as the processes themselves. Distributed systems, which are the result of the interaction between self-sufficient units, are more flexible and adaptable to change. Because they draw on local resources, they make less of an impact on the territory, on mobility and the consumption of systemic resources. And with increased self-sufficiency in the multiple layers of the management of our habitat comes increased decision-making capability about what kinds of habitable spaces we wish to develop, and at what pace.

"DISTRIBUTED SYSTEMS, WHICH ARE THE RESULT OF THE INTERACTION BETWEEN SELF-SUFFICIENT UNITS, ARE MORE FLEXIBLE AND ADAPTABLE TO CHANGE."

FAB CITY GLOBAL INITIATIVE

LOCALLY PRODUCTIVE, GLOBALLY CONNECTED SELF-SUFFICIENT CITIES



The Fab City Global Initiative is making a new urban future possible by helping cities produce everything they consume by 2054. It brings together top-tier research institutions, governments, and large corporations to collaborate on transforming the current extractive urban model through experimentation and knowledge-sharing. Called the Fab City Collective, it functions as a distributed body of research and development, supported by individuals and recognized institutions in Europe and the world. More than 1,250 fabrication laboratories (Fab Labs) and the thousands of members of a global community that's stretched across the entire globe support this distributed network for urban innovation, prototyping, and production. These labs run research and educational programs in the Academy of Almost Anything and support companies and universities. Fab City supports the Mass Distribution of Design and Making as a way of forging future change-makers, prepared to take on climate change and increase the social impact that digital technologies can offer.

TIMELINE — EVENTS THAT LED TO FAB CITY

2003

The first Fab Lab is established at the South End Technology Center, in Boston, as a result of a collaboration between the National Science Foundation and the Center for Bits and Atoms at MIT.

New Fab Labs are set in Costa Rica, Ghana, India, and Norway. The next labs open in South Africa and Iceland.

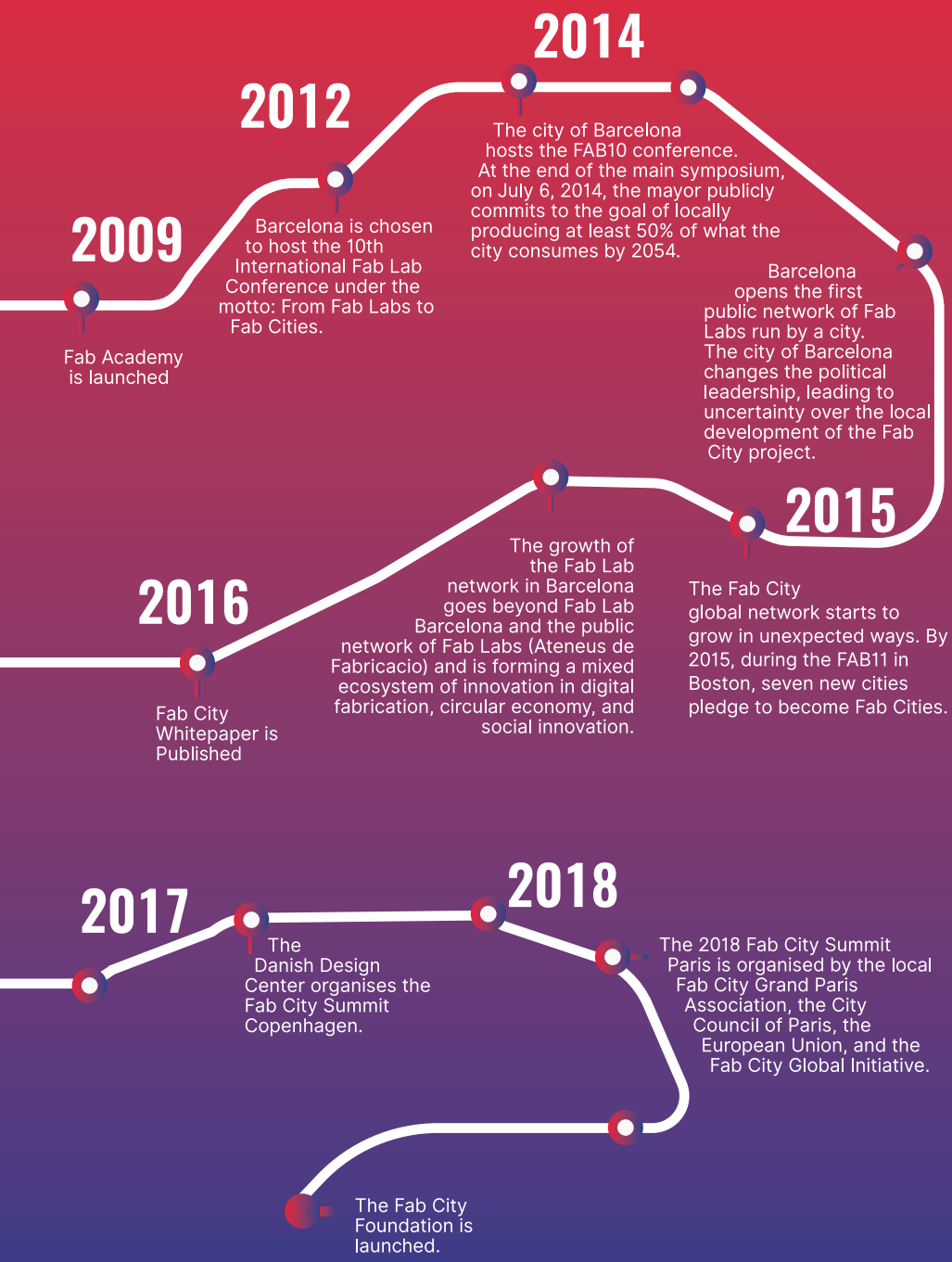
2007

Fab Lab Barcelona is established within the Institute for Advanced Architecture of Catalonia. A few years later, some of IAAC's founding members become part of Barcelona's city government. Barcelona becomes the first EU-based Fab Labs of the global network, followed by Amsterdam.

Articulating the global efforts, the Fab City Campus is organised in Amsterdam by Pakhuis De Zwigjer, as part of events marking the Dutch EU presidency. Amsterdam joins the Fab City Global Initiative.

Space10, IKEA, and IAAC organise the Made Again Challenge and launch The Fab City Prototype in Poblenou, Barcelona's official "Maker District."

The FAB12 conference takes place in Shenzhen, China, with six new cities joining the Fab City Global Initiative.


2009
Fab Academy is launched
2012
Barcelona is chosen to host the 10th International Fab Lab Conference under the motto: From Fab Labs to Fab Cities.
2014
The city of Barcelona hosts the FAB10 conference. At the end of the main symposium, on July 6, 2014, the mayor publicly commits to the goal of locally producing at least 50% of what the city consumes by 2054.
Barcelona opens the first public network of Fab Labs run by a city. The city of Barcelona changes the political leadership, leading to uncertainty over the local development of the Fab City project.
2015
The Fab City global network starts to grow in unexpected ways. By 2015, during the FAB11 in Boston, seven new cities pledge to become Fab Cities.
The growth of the Fab Lab network in Barcelona goes beyond Fab Lab Barcelona and the public network of Fab Labs (Ateneus de Fabricacio) and is forming a mixed ecosystem of innovation in digital fabrication, circular economy, and social innovation.
2016
Fab City Whitepaper is Published
2017
The Danish Design Center organises the Fab City Summit Copenhagen.
2018
The 2018 Fab City Summit Paris is organised by the local Fab City Grand Paris Association, the City Council of Paris, the European Union, and the Fab City Global Initiative.
The Fab City Foundation is launched.

FAB CITY WHITEPAPER

LOCALLY PRODUCTIVE, GLOBALLY CONNECTED SELF-SUFFICIENT CITIES

FAB CITY COLLECTIVE

More than 200 years since the Industrial Revolution, global urbanisation keeps accelerating. United Nations projections suggest that 75 % of the human population will be living in cities by 2050. Newly created cities and the urbanisation process in rural areas replicate a lifestyle based on consumerism and the linear economy, causing destructive social and economic impact while compromising the ecology of the planet. We are losing livelihoods through both offshoring and automation, and this in turn leads to the demise of dynamic hubs of practical and cultural knowledge, at the sites where things are made. Extreme industrialisation and globalisation have turned cities into the most voracious consumers of materials, and they are overwhelmingly the source of carbon emissions through both direct and embodied energy consumption.

By now, it's become clear. We need to reimagine cities and the ways they operate.

FROM LINEAR TO SPIRAL PRODUCTION ECOSYSTEMS

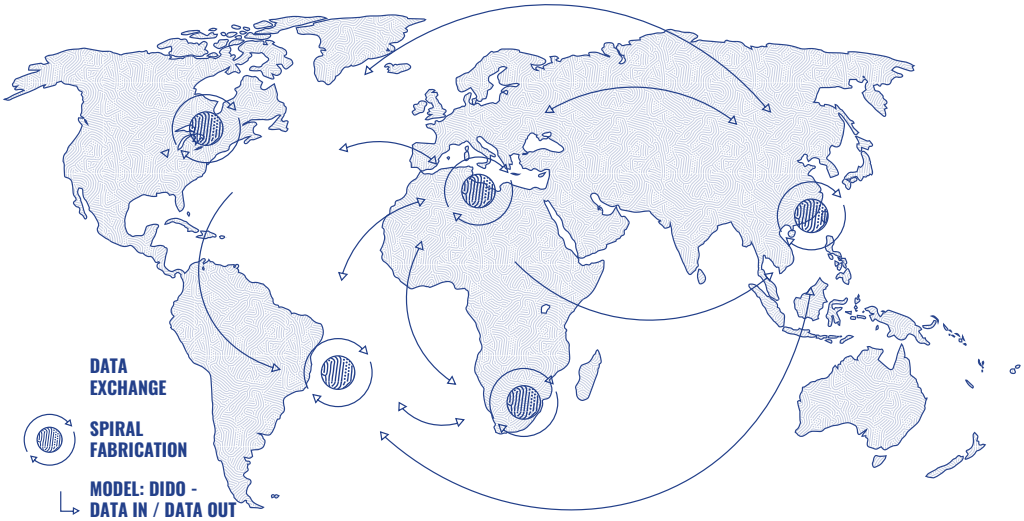


Figure 1. Where do we make things?
Source: Fab City.

The Fab City is an international initiative started by Institute for Advanced Architecture of Catalonia (IAAC), the MIT's Center for Bits and Atoms (CBA), the Barcelona City Council and the Fab Foundation to develop self-sufficient cities that are at once locally productive and globally connected. The project is connected to the global network of Fabrication Laboratories, or Fab Labs, and made up of an international think tank of civic leaders, makers, urbanists and innovators working on changing the paradigm of the current industrial economy. Under the model, the city operates in a linear fashion, importing products and producing waste. Our aim is to move to very different model—to an ecosystem of spiral innovation in which materials flow within cities, and information about how things are made circulates globally. Fab City is about building a new economy based on distributed data and manufacturing infrastructure.

Introduction

We need to reinvent our cities and their relationship to both people and the planet by re-localising production so that cities are generative rather than extractive; restorative rather than destructive; and empowering rather than alienating; where prosperity flourishes; and people have purposeful, meaningful work that they enjoy and enables them to use their passion and talent. We need to recover the knowledge of how things are made in our cities and the capacity to put it into practice by connecting citizens with the advanced technologies that are transforming our everyday lives.

Background

For more than 10 years, Fab Labs have provided widespread access to modern means for invention and production. They began in 2003 as an outreach project from MIT's CBA. From inner-city Boston, they quickly spread across the globe, mushroom up everywhere from rural India to South Africa to northern Norway. All sorts of things go on in this global network: Fab Labs play host to everything from technological empowerment initiatives to peer-to-peer project-based technical training to local problem-solving to small-scale high-tech business incubation to grass-roots research. Projects being developed and produced in Fab Labs include solar and wind-powered turbines, thin-client computers and wireless data networks, analytical instrumentation for agriculture and healthcare, custom housing, and rapid-prototyping of rapid-prototyping machines.

THE CITY:
A LINEAR TRASH MACHINE

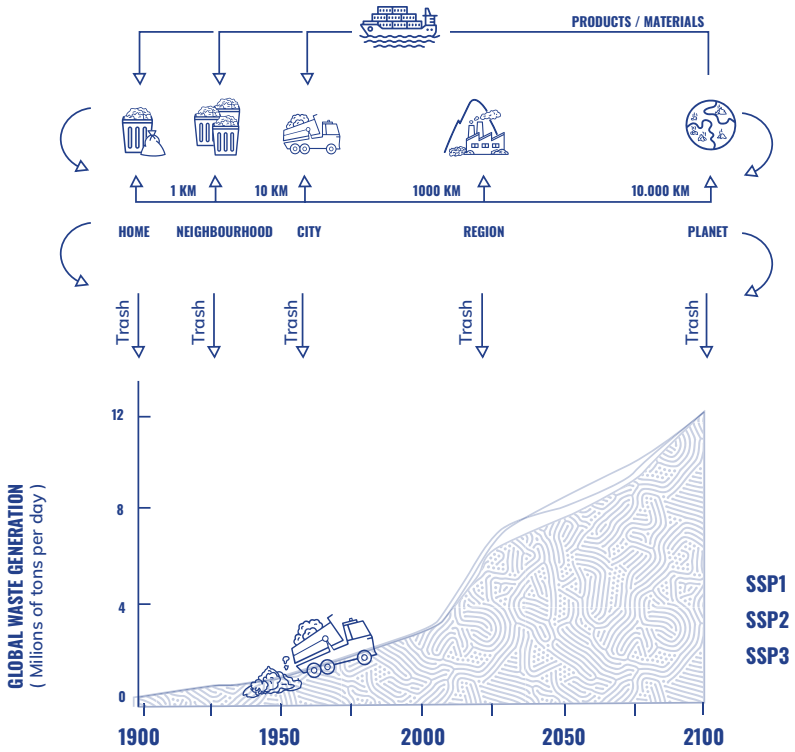


Figure 2. "Three projections to 2100 for waste generation spell very different futures. In the first Shared Socioeconomic Pathway scenario (SSP1), the 7-billion population is 90 % urbanised, development goals are achieved, fossil fuel consumption is reduced and populations are more environmentally conscious. SSP2 is the 'business-as-usual' forecast, with an estimated population of 9.5 million and 80 % urbanization. In SSP3, 70 % of the world's 13.5 billion live in cities and there are pockets of extreme poverty and moderate wealth, and many countries with rapidly growing populations." Graphic source: Fab City. Data source: Organisation for Economic Co-operation and Development / Interpretation by Daniel Hoornweg, Perinaz Bhada-Tata & Chris Kennedy for "Environment: Waste production must peak this century," published in *Nature*, October 30/2013 at http://www.nature.com/news/environment-waste-production-must-peak-this-century-1.14032.

Fab Labs share core capabilities among the nearly 1,278[1] labs in operation as of May 2018, meaning that people and projects can be shared across the network. These labs work with components and materials optimized for use in the field and are controlled with custom software for integrated design, manufacturing, and project management. This inventory is continuously evolving towards the very meta goal of one Fab Lab being able to make another fab lab.

Since 2001, the IAAC and the MIT's CBA have been working together to develop a new approach to architecture and urbanism by understanding how the use of digital technologies will impact our cities. Founded back in 2007, Fab Lab Barcelona at IAAC was the first fabrication laboratory in the European Union, and is now the headquarters for global coordination of the Fab Academy program, the Fab Labs.io platform and the Smart Citizen project—making it the world's leading lab for the Fab Lab Network, in collaboration with the Fab Foundation.

In 2011, at the 7th annual International Fab Lab Forum in Lima, Peru, IAAC, the MIT's CBA, the Fab Foundation and Barcelona's City Council launched the Fab City project. Seven years later, at the FAB10 conference, Barcelona's mayor invited other leaders from across the globe to join his city and accept the challenge of becoming at least 50 % self-sufficient by 2054. Since then, more than a dozen cities—including Shenzhen, Santiago de Chile and Paris—as well as several regional governments and even a whole country, Bhutan, have joined what has come to be known as the Fab City Global Initiative, with more signing on all the time to collectively build a more humane and habitable new world.

Details

Fab City takes the ideals of the Fab Lab—the connectivity, culture and creativity—and scales them up metropolitan scale, to meet the needs of entire cities. It has become a new model for urban transformation that radically overhauls how cities they source and use materials, moving from a 'Products In Trash Out' (PITO) paradigm to the infinitely more efficient 'Data In Data Out' (DIDO) system. This means that more production occurs within the city itself, as does recycling and urban mining of materials to be reinserted in supply chains. Meeting local needs through local inventiveness becomes one of the city's core strengths, and under this model, the lion's share of imports and exports are found in the form of data (information, knowledge, design, code).

1 https://www.Fab Labs.io/labs

RESCALING GLOBAL MANUFACTURING

MODEL: DATA IN / DATA OUT

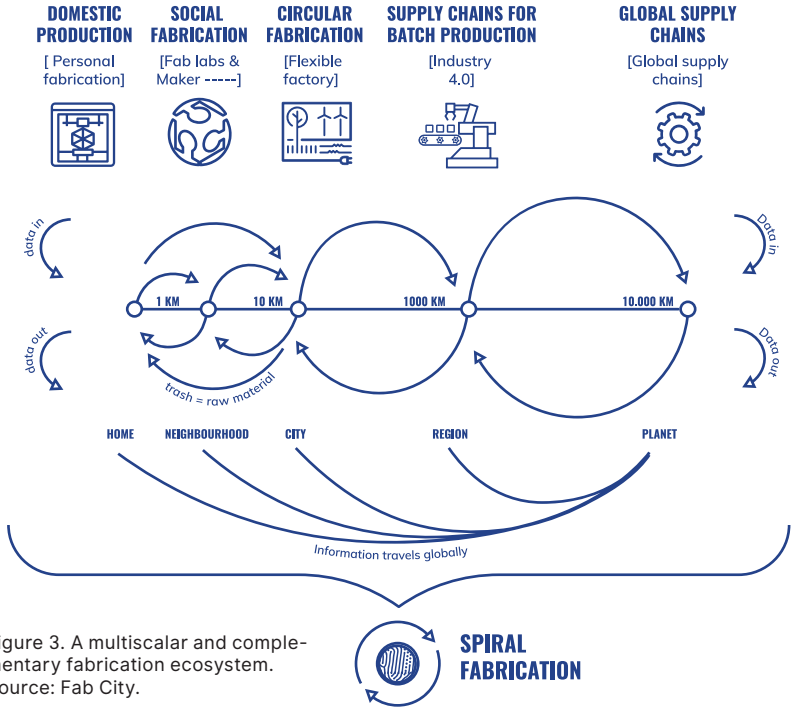


Figure 3. A multiscalar and complementary fabrication ecosystem. Source: Fab City.

The Fab City project will help civic leaders develop locally productive cities in collaboration with local communities, companies and institutions, revitalising manufacturing infrastructure and incentivising a new economy. As spaces of learning, where new skills are developed and honed, Fab Labs are giving people the know-how they need to remain employable in this fast-evolving economy and also providing businesses with the on-point workforce they require. Fab Lab and makerspaces are also giving local businesses a boost by helping develop solutions to local problems, while reactivating metropolitan and regional manufacturing ecosystems. And with their longstanding ethos of slashing carbon emissions and creating zero-waste systems, the Fab City approach can help cities reach a whole range of objectives, from environmental goals to human development targets.

In this way, cities and their citizens are empowered to be the masters of their own destiny: Both become increasingly resilient, even as their ecological footprints diminish with the decrease in the carbon-spewing movement of goods and materials.

In order for this to be possible, the city must be locally productive and globally connected to knowledge, economic and social networks, making cooperation between cities, citizens and knowledge centers the basis of the scientific knowledge.

To become a FAB City requires having a more precise understanding of the ways cities work and developing metrics to measure progress towards the established target of 2054. The evolution of the project will make it possible to create better systems for capturing and analysing data, thus allowing for a more granular picture of any given city. It will also require the implementation of an evaluation system and detailed monitoring.

The Fab City strategy is unique in that it addresses a range of environmental, social and economic objectives (carbon reduction, waste minimisation, relocalisation of manufacturing and employment) within a systems approach by harnessing new technology and production approaches. All of this is brought to a practical level by tapping into the existing Fab Lab Network, a vast source for urban innovations being shared already globally by makers in some 1,278 labs in more than 90 countries. In this way, Fab Labs and makerspaces are catalysts for the transition towards the Fab City objectives. They do not replace industry or businesses but instead reactivate local production by creating new demands for shorter supply chains while accelerating innovation by creating the new technologies needed for this new style of productive urban living.

The first city to become self-sufficient—simultaneously increasing employment by creating opportunities through open innovation and radically reducing carbon emissions by re-localising production—is sure to become a global trailblazer for urban development across the planet.

Strategies

The core Fab City strategy is to develop a global network of cities that are part of a sustainable ecosystem of production and knowledge: from the 3D printer at home, to the neighborhood Fab Lab, to the city factory to global production infrastructure. A new manufacturing ecosystem to rescale globalisation and provide the means of innovation and production to citizens, who in that way become empowered to lead the transformation of their cities.

Becoming a Fab City involves working in the following specific strategies:

- **Advanced Manufacturing Ecosystem:** Being part of a global network of cities that share knowledge and best practices on urban solutions emerging from citizens, companies, educational institutions, and governments. Local networks of Fab Labs and mid-scale production centers connected to the larger global network of supply chains, sharing knowledge, best practices and projects.
- **Distributed Energy Production:** With the advent of domestic batteries and efficiency improvements in solar and other means of clean power generation, energy distribution itself will face enormous changes. Distributed grids will change the role of households and businesses in power, water and resources distribution.
- **Cryptocurrencies for a New Value Chain:** Cities creating their own trade markets connected to a global economy, using a multi-currency and value system based on the blockchain and similar technologies.
- **Food Production and Urban Permaculture:** Urban farming will scale up from experimental practice to large-scale infrastructure. Local production of foods at the domestic, neighbourhood and city scales will create a closed loop system for food production and harvesting.
- **Educating for the Future:** Incorporating a stronger emphasis on learning-by-doing in education systems and curricula, engaging all levels of education in finding solutions for local needs through digital fabrication technologies, and sharing them with global networks.
- **Building the Spiral Economy:** Reduce the amount of imported goods, food and resources such as water or energy. Increase the use of recycled raw materials for the production of objects in cities. Create added value in every iteration of a new product.
- **Collaboration between Governments and the Civil Society:** Local government and civic organizations, start-ups, universities, and other organizations must work together in order to make a cultural shift that promotes the empowerment of cities and their citizens.

All these efforts will be supported by technologies such as digital manufacturing, the rehabilitation of buildings and neighbourhoods aimed at making them more energy efficient, smart energy networks, electrical mobility, urban permaculture, intelligent infrastructure, and related policy and regulatory approaches, among other solutions to be shared globally between cities.

Benefits

This initiative offers a multitude of valuable economic opportunities for participating cities. It will create new types of jobs and professions tied to the knowledge economy and the development and implementation of new approaches and technological solutions. The Fab City initiative will develop a set of associated services:

- **Mapping** the existing innovation and production ecosystems in cities. Understanding the existing manufacturing infrastructures, networks of knowledge, initiatives, communities and other organisations that are pursuing systems change in participating cities.
- **Establishing metrics** to evaluate impact in each participating city. Developing common standards and sharing best practices in terms of local production. A Fab City data dashboard.
- **Developing products** that can be produced locally and shared globally that include everything from objects to food to waste management or even energy harvesting solutions. A global Fab City repository.
- **Deploying interventions.** Running a Fab City Blockchain amongst the participating cities as a decentralised autonomous organisation
- **Articulating** with other groups of interest and networks. Fab City is not the only initiative looking into the future of cities. We aim to build bridges with existing research and initiatives that have long been contributing to forging a better understanding of urban life.
- **Organising** a yearly event at Fab Conferences and complementary events in different cities of the world.

These associated services should lead to a business model for Fab City to exist as an international organisation, which will be established by its founding members (IAAC, MIT's CBA and Fab Foundation) and by inviting associated members to share rights and duties.

FROM LINEAR TO SPIRAL PRODUCTION ECOSYSTEMS

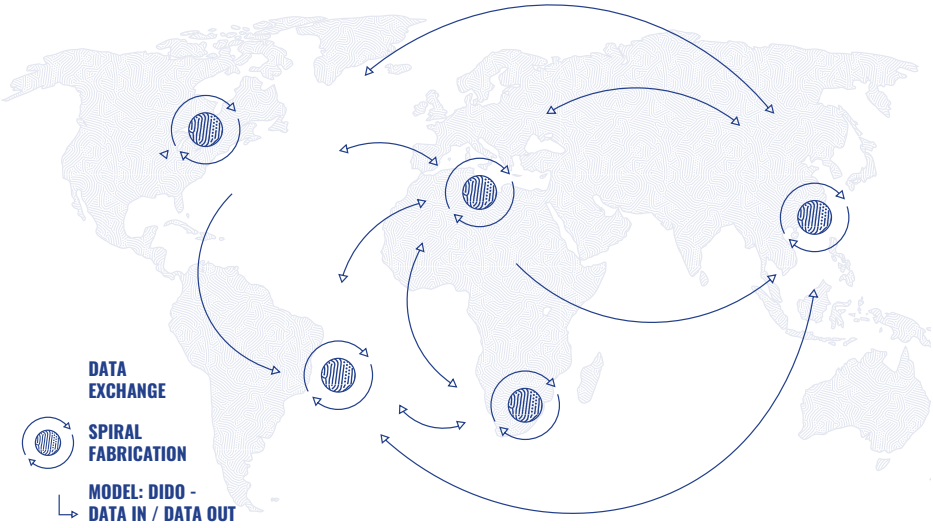


Figure 4. Globally connected production. Materials stay within accepted distances in cities and regions, information travels on how things are made. We share the recipes for how to construct our world. Source: Fab City.

Conclusion

A concerted and coordinated response must be made to reimagine what we make, and how and where we make it, if we are to live harmoniously within the limits of our planetary resources. We are proposing a model for cities to be resilient, productive and self-sufficient in order to respond to the challenges of our times and recover the knowledge and the capacity to make things, produce energy, harvest food, understand the flow of matter, and empower citizens to become be the leading agents of their own destiny. We have a unique opportunity to build cities from the ground up by synchronising philosophies, visions and objectives together with existing distributed innovation ecosystems, to consolidate and nurture the knowledge-based economy that's been developing over the last decade in Fab Labs, Makerspaces and open communities around open source innovations, digital fabrication technologies and distributed digital networks. We want to create a global database of recipes for how things are made, from what and why. The Fab City is about radical transformation—about rethinking and changing our relationship with the material world so that we as a species can continue to flourish on this, our precious planet.

THE FAB CITY MANIFESTO

MAP TO NAVIGATE FAB CITY

PEOPLE-CENTRED

We give priority to people and culture over technology, so that the city can become a living and resilient ecosystem. Autonomous vehicles, digital tools, artificial intelligence and robotic machines must be placed at the service of the people's well-being and expectations.

HOLISTIC

We address urban issues in all their dimension and interde- pendencies to build sustainable, resilient and inclusive cities for everyone.

LOCALLY PRODUCTIVE

We support the efficient and shared use of all local available resources in a circular economy approach, to build a productive and vibrant city.

PARTICIPATORY

We engage with all stakeholders in decision-making processes and empower citizens to take ownership of innovation and change-making.

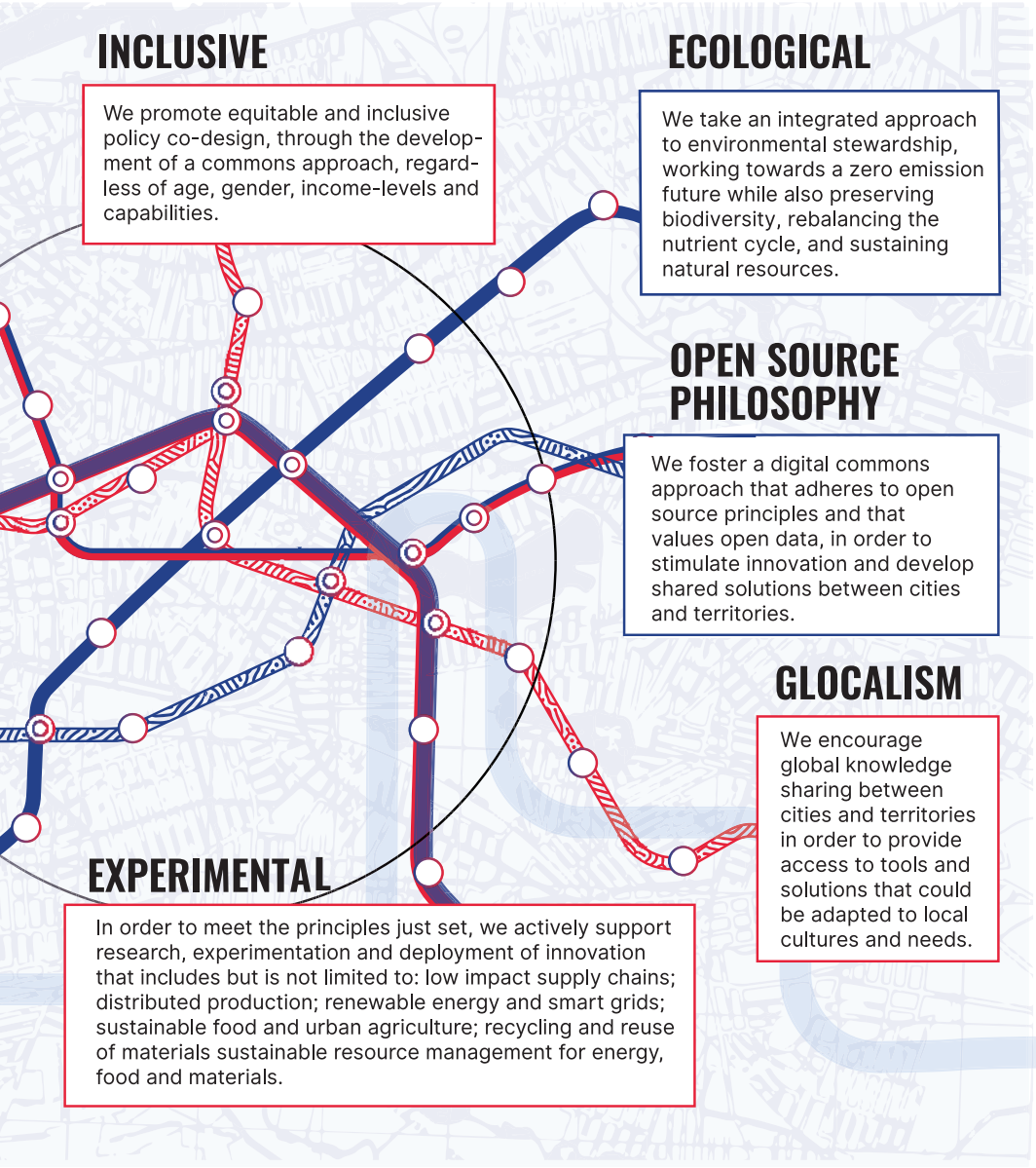
ECONOMIC GROWTH & EMPLOYMENT

We support sustainable urban economic growth by investing in building the skills, infrastructure and policy frame- works needed for the 21st century, thanks to a thorough consideration of social and environmental externalities and the implementation of the polluter pays principle.

VALUES

- Sustainability line
- Respect line
- Collaboration line
- Trust line
- Accessibility line

We, as signatories, commit ourselves to implement the ten following principles to enable the urban transition towards locally productive and globally connected cities. We embrace strategies in circular economy and digital social innovation, and foster collaboration between a global network of European and world-wide cities and territories to meet the planetary challenges presented by climate change and social inequality.



INCLUSIVE

We promote equitable and inclusive policy co-design, through the development of a commons approach, regardless of age, gender, income-levels and capabilities.

ECOLOGICAL

We take an integrated approach to environmental stewardship, working towards a zero emission future while also preserving biodiversity, rebalancing the nutrient cycle, and sustaining natural resources.

OPEN SOURCE PHILOSOPHY

We foster a digital commons approach that adheres to open source principles and that values open data, in order to stimulate innovation and develop shared solutions between cities and territories.

GLOCALISM

We encourage global knowledge sharing between cities and territories in order to provide access to tools and solutions that could be adapted to local cultures and needs.

EXPERIMENTAL

In order to meet the principles just set, we actively support research, experimentation and deployment of innovation that includes but is not limited to: low impact supply chains; distributed production; renewable energy and smart grids; sustainable food and urban agriculture; recycling and reuse of materials sustainable resource management for energy, food and materials.

THE FAB CITY NETWORK 2018

There are 28 cities that have already joined the Fab City Network. Each city forms a local consortium or ecosystem, which gathers public institutions, private initiatives, companies and individuals developing the Fab City vision locally, while connected to the global network.

BARCELONA
EKURHULENI
AMSTERDAM
BHUTAN
BREST
CAMBRIDGE
SHENZHEN
BOSTON
KERALA
GEORGIA
TOULOUSE
SACRAMENTO
CURITIBA
AUVERGNE-RHÔNE- ALPES
PARIS
SOMERVILLE
OCCITANIE REGION
SANTIAGO DE CHILE
DETROIT
KAMAKURA
PUEBLA
VELSEN
SOROCABA
MEXICO CITY
SEOUL
ZAGREB
OAKLAND
BELO-HORIZONTE

41°23'N 2°11'E JOINED 2014

BARCELONA
SPAIN

Barcelona is a world-leading city in the field of urbanism. The city's iconic urban model, conceived by Ildefons Cerdà, was designed in response to the industrial revolution. During the 20th century, the city perfected this urban model, thanks to the contributions of its architecture, urbanism and design ecosystems. Key events such as the 1992 Olympic Games and, more recently, the Mobile World Congress and the Smart City Expo have led to improvements in the physical and digital infrastructure of this exemplary city. The early adaptation of innovative initiatives helped Barcelona gain an international reputation for collaboration in urban innovation, and in 2014, the city was the recipient of the inaugural European iCapital award.

In recognition of this alignment of objectives between different players in the city, Barcelona took another step towards establishing a new urban model, adapted to the needs of the 21st century: the Fab City. This vision was laid out during the 10th International Fab Lab Conference, entitled "From Fab Labs to Fab Cities" (2014), where Barcelona launched a worldwide challenge: an invitation for municipal officials to commit to move over the following 40 years toward a local production model that would see participating cities produce fully half of everything they consume by 2054.

Barcelona is one of the pioneers of the Fab City concept. It's the site of the first Fab Lab in the European Union (Fab Lab Barcelona)

© Vicens Tomàs

and the first public network of Fab Labs (Ateneus de Fabricació). Municipal-owned labs are scattered throughout the city to enable city residents to learn, work, and collaborate to make their ideas come true through digital manufacturing and the collaborative economy. The city also provides support to the Poblenou Maker District, a post-industrial neighbourhood flagship project for the re-industrialisation 4.0 process. The district is dedicated to fostering innovation and providing extra visibility to the network that already existed in this area, which harnesses technology to transform and improve people's lives and bolster sustainability. Maker culture flourishes through initiatives such as the Matins Makers, regular meetings of the Barcelona community aimed at strengthening links and promoting collaboration and debate, as well as the Maker Faire Barcelona, the city's flagship event for makers.

Today, Barcelona is one of the richest scientific ecosystems in Europe, as well as the home of many initiatives related to technological innovation, such as the Barcelona Institute of Science and Technology, the Barcelona Supercomputer Center, the Institute for Advanced Architecture of Catalonia, and many other universities and research organizations—all of them actively supported by the City Council.

What have been the highlights and lessons from your Fab City journey so far?

In recent years, Barcelona has incorporated many elements related to Fab City into its technological and innovation policy. Since 2016, with the Barcelona Digital City Plan, the city has been working toward becoming a more open, circular/sustainable, collaborative, inclusive, and democratic city. This policy focuses in the following ideas: Using a collaborative approach to promoting the city of Barcelona as a tech hub, involving the Quadruple Helix in the innovation processes, and leveraging collaborations between the public administration and the research sphere, and big and small companies—while always keeping citizens squarely at the centre of policy. Being circular and sustainable, and fostering innovation to improve sustainability and scalability, while taking into consideration local economies and the neighborhood challenges through a bottom-up approach, and also maximizing initiatives' social impact. Other goals include boosting the ethical and responsible use of technology and data with open and digital ethical standards, empowering citizens to control their personal information, and expand the use of open technologies. And, of course, in order to be inclusive and democratic, citizens must be empowered to be able to take part in this Fab City.

Citizen-centred policies are required to maximize the social impact, as well as enable training programmes in the use of technologies to solve personal challenges. For example, Fab Lab Barcelona is now fuelling the Fab Lab Network by coordinating the educational programs at the Academy of Almost Anything (Academany). The knowledge acquired there is shared with the Barcelona City Council are then shared with other cities around the world, thanks to global collaboration platforms like Fab Labs.io and the Fab City Global Initiative—in which Barcelona organizes those participating in the project and supports international events, such the Fab City Summit in Amsterdam, Copenhagen, and Paris, and, two years from now, in Montreal.

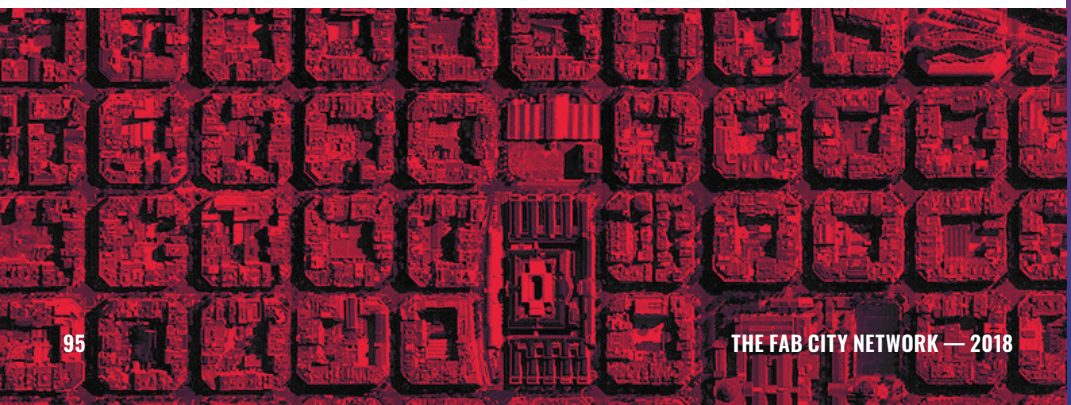
In summary, we have learned that only through a real collaboration between the public sector and civil society will it be possible to produce the impact necessary for cities to transition towards a more inclusive and sustainable economy and lifestyle.

What is the current and future agenda of your Fab City activities?

The Fab City model is one of the priorities of our city and we're dedicating plenty of assets toward achieving it. Fab Lab Barcelona is one of the main avenues, supporting events and projects such as FAB10, the Made Again Challenge, in collaboration with Space10, IKEA, IAAC, Fira de Barcelona, and the local and global network of designers and makers. The city is now home of various European-funded projects under different frameworks, such as H2020 and Creative Europe, which are allowing for different stakeholders to collaborate in a more horizontal way. Additionally, Barcelona is adopting the Fab City strategy, with a bottom-up approach, focused on the empowerment of citizens and makers, thanks, in part, to the support of the City Council's Commissioner of Technology and Digital Innovation. It supports urban experimentation initiatives such as the iLab, the use of technologies for citizen's digital rights in the DECODE project, and the continuous support of the commons-based economy through entrepreneurship plans.

There are plenty of projects under way that will allow urban experimentation to develop future urban tools using not only digital fabrication technologies, but also to test and make accessible artificial intelligence tools, blockchain applications, and breakthroughs in synthetic biology.

We aim to continue inspiring the world and sharing our experience and knowledge in an open source model to help the Fab City philosophy to grow and develop worldwide to achieve the technological sovereignty of citizens.



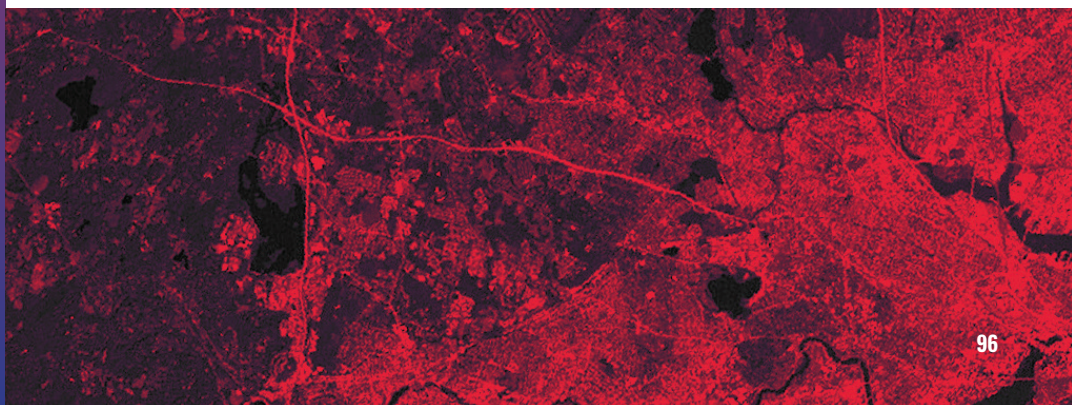
42°38'76"N 71°09'95"E JOINED 2015

SOMERVILLE USA

Somerville is a city of makers with a long history of manufacturing and creation. Over the past decade, many older industrial buildings here have been transformed into artists' studios, makerspaces, and incubators, thus touching off a whole new era of fabrication in the city. In order to extend the economic opportunities provided by this creative economy to the whole community, we and our partners launched FabVille, a free, public makerspace located in the Somerville High School.

What have been the highlights and lessons from your Fab City journey so far?

When we began FabVille, we were unsure of the target audience and goals of the space. Since its inauguration, we've come to the realization that the Fab Lab operates best as a digital literacy training space, providing residents with the tools to operate in a digital economy. The most important skills we can provide, we've learned, are cognitive skills, including, for example, computation and critical thinking.



What is the current and future agenda of your Fab City activities?

Our future strategy involves connecting the competencies learned in FabVille to open up further employment and entrepreneurship opportunities.

Strategic Focus:

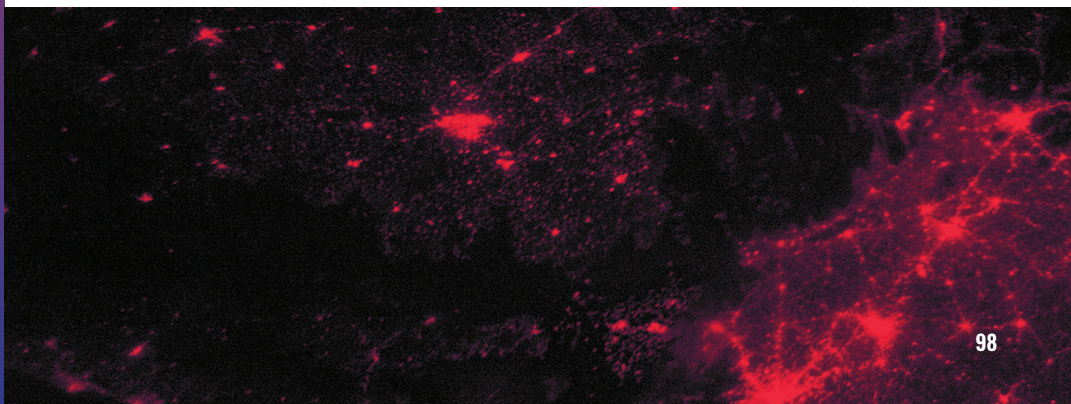
Education and learning; policy and governance/ownership; citizen engagement/grassroots innovation.

10.8505° N, 76.2711° E JOINED 2015

KERALA
INDIA

Manufacturing in Kerala was long driven by traditional practices, with people harnessing the resources of the natural environment. But these traditional industries have largely struggled to keep pace with the galloping advance of technology, and people began to gravitate toward consumerism.

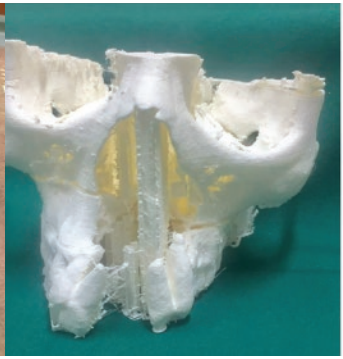
Still, Kerala boats an energetic, young workforce. Its 100% literacy rate has helped fuel a shift toward a knowledge-driven economy. The state government is eager to throw its support behind this trend and cement Kerala's status as a digital society. The goal is to provide the people of Kerala with the tools and technology to make the best use of the state's resources.



What have been the highlights and lessons from your Fab City journey so far?

Kerala is now home to two standard Fab Labs that are extending the means of manufacturing to a much broader swath of the population. Thanks to the stalwart support of the Government of Kerala, APJ Abdul Kalam Technological University, and the Fab Foundation, Fab Lab Kerala has also established 20 mini Fab Labs within selected engineering colleges throughout the state. Those mini Fab Labs were rolled out over the space of six months and have been operational since August, 2017.

Fab Lab Kerala organized a three-day-long digital fabrication workshop called FabXL, aimed exclusively at engineering students, and successfully conducted the workshops at more than 15 locations across the state. Fab Lab Kerala has joined with MIT's Center for Bits and Atoms to take part in the Fab Lab 2.0 project. We hope to capitalize on the machines-making-machines framework to produce machinery for our mini labs, statewide.

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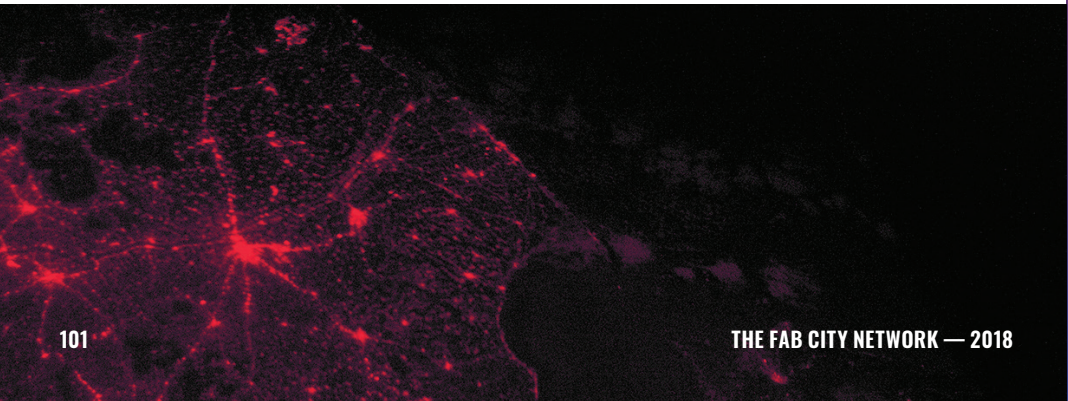
What is the current and future agenda of your Fab City activities?

Our overarching goal is to create awareness of our work and a broad understanding of how it can be used by the population, as well as to help forge a new generation of skilled makers. In the end, we know that the larger stumbling block lies not in the availability of the machines or even the lack of manpower, but rather in a dearth of know-how and skills.

We hope to bring the means of manufacturing to an ever-wider swath of Kerala's population by making more people aware of our two state-of-the-art Fab Labs. In the same spirit, we hope to build a strong knowledge-sharing network that will allow us to easily draw upon open source projects and other shared resources. This will, of course, help further our wider project of rationalizing the use of resources in order to build the circular economy of the future.

Strategic Focus:

Distributed manufacturing; education and learning.



GEORGIA

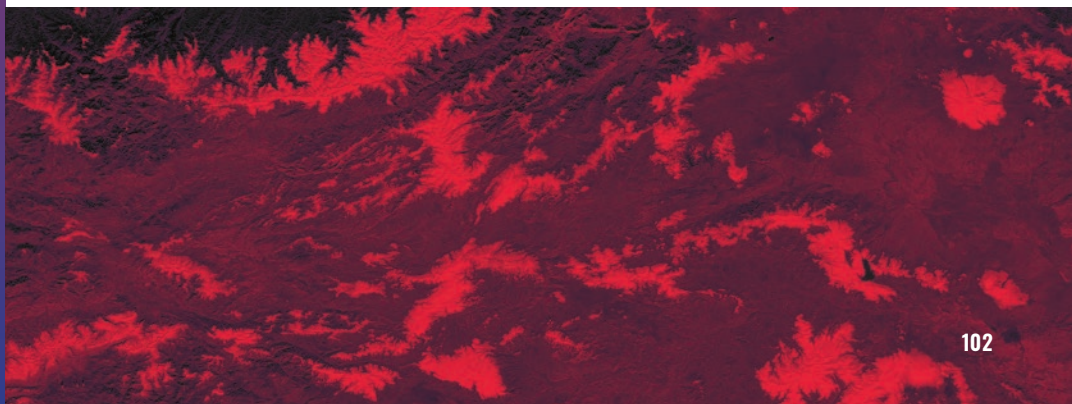
GEORGIA

Georgia joined the global Fab Lab community as the first "Fab Country," in 2015. Our first Fab Lab was opened at the Ilia State University, and since then 22 other Fab Labs have been rolled out in every region and most of the major cities throughout the country.

In becoming the first Fab Country, Georgia took on a huge challenge, and the government has been instrumental in supporting the project. The ministry of economy and sustainable development has taken an active role in promoting digital fabrication as tool for economic development not only on the national scale, not but on the personal level, allowing citizens to start their own businesses and make their dreams reality.

What have been the highlights and lessons from your Fab City journey so far?

We have been organizing events, dubbed Fab Talks or Fab School, to inform the Georgian public about the Fab Lab network and the many opportunities it offers. These events have strengthened the Fab Community in Georgia and provided the wider community with information about possibilities and opportunities that are open to them around the world.



Start-ups linked to the Fab Lab network are developing “smart devices,” such as a smart Wi-Fi thermostat, and are looking for investors to help take their ideas to the next level.

What is the current and future agenda of your Fab City activities?

We are organizing informative events - Fab Talks, Fab School for interested people to strengthen Fab Community in Georgia and give more information about new possibilities and opportunities around the world.

Strategic Focus:

Design decision-making; education and learning; policy and governance/ownership.

22.5431° N, 114.0579° E JOINED 2016

SHENZHEN
CHINA

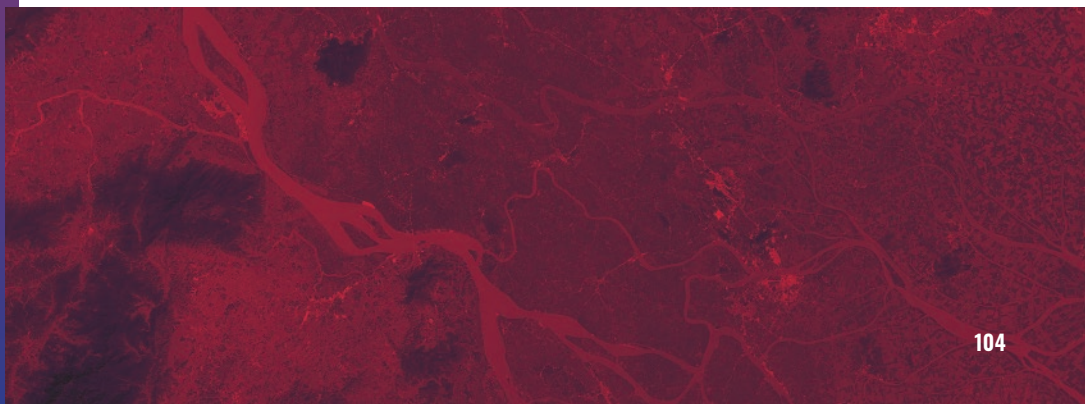
Shenzhen is located in the heart of the Pearl River Delta, which is known as the factory of the world for the sheer density of its manufacturing sector. Shenzhen alone now produces an estimated 90% of the world's electronics, making it a unique setting for a Fab City.

Shenzhen joined the Fab City network in 2016, the same year it hosted the FAB12. While most cities in the network are aiming to beef up their metropolitan manufacturing sector, Shenzhen, on the other hand, is attempting to reduce the spread and magnitude of its manufacturing sector.

With all the focus on the galloping pace of development in China, it's easy to forget that China is still a developing country, with tens of millions of people still living at or under the poverty line. But such abject poverty continues to be a fact of daily life in many of the rural villages that ring Shenzhen. For that reason, we're interested in exploring how the Fab City model can help improve the lives of China's rural poor.

What have been the highlights and lessons from your Fab City journey so far?

Our Fab City project is among the sites hosting the British Council's "Hello Shenzhen" Residency, which gave two researchers, Katrine



Hesseldahl and Victor Strimfors, the opportunity to explore the production capacities of urban villages. Their research centered around Shawei, an urban village in Shenzhen's so-called Special Economic Zone.

At the end of the residency, the pair hosted a chair-making workshop, during which participants designed and built their own chairs in shops located within a few square blocks of the urban village and created a map identifying production facilities and material inventories that allowed even novices makers like the workshop participants to make their own chairs.

What is the current and future agenda of your Fab City activities?

Shenzhen is at the centre of the global maker movement as the place where maker entrepreneurs flock in order to scale their projects from prototype to production. We plan to develop our Shawei facility into a site where global makers can work and stay while they're in Shenzhen. In this way, they'll be able to experiment even as they prototype, thus helping build the future of Fab City. We also plan to work with universities and research organizations on collaborations and prototype projects in and around Shawei. We're also launching a Fab Village project in rural Fujian province to further explore how technology can help bring economic growth to rural China.

Strategic focus:

Distributed manufacturing; distributed energy production; artificial intelligence; synthetic biology; distributed food production; education and learning; circular economy/ doughnut economics; standards and regulations; citizen engagement/grassroots innovation.

52.3702° N, 4.8952° E JOINED 2016

AMSTERDAM NETHER-LANDS

In 2016, the European Commission named Amsterdam the European Capital of Innovation. In addition to being a widely recognized centre of cutting-edge industry and science, the city shines when it comes to bottom-up innovation, under which organizations and residents come up with their own solutions to local problems. Amsterdam approaches innovation not only as a technical challenge, requiring top-down management, but as a wider social challenge that necessitates smooth collaboration between municipal authorities, institutions of higher learning, businesses, industry, and residents. In Amsterdam, we regard bottom-up initiatives as serving the best interest of all the above stakeholders.

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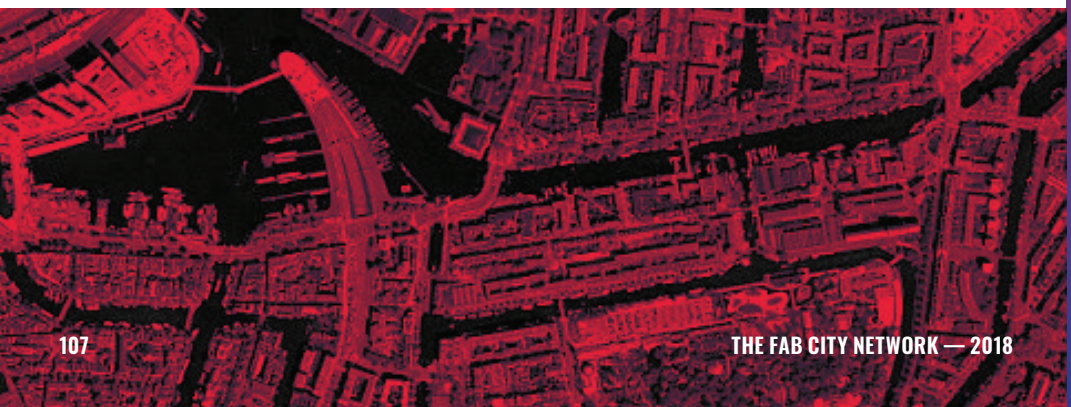
To showcase this unique mindset, Amsterdam joined the Fab City initiative at the Fab12 international meeting in Shenzhen, China, in 2016. Becoming a Fab City represented the logical next step toward the goal of promoting decentralized manufacturing and empowering citizens. For us, the Fab City model embodied a new understanding about the ways in which cities should evolve, provide for their citizens, and manage resource streams. As a hub for the circular economy and urban sustainability, Amsterdam hosts a number of organizations that are closely connected to the Fab City agenda.



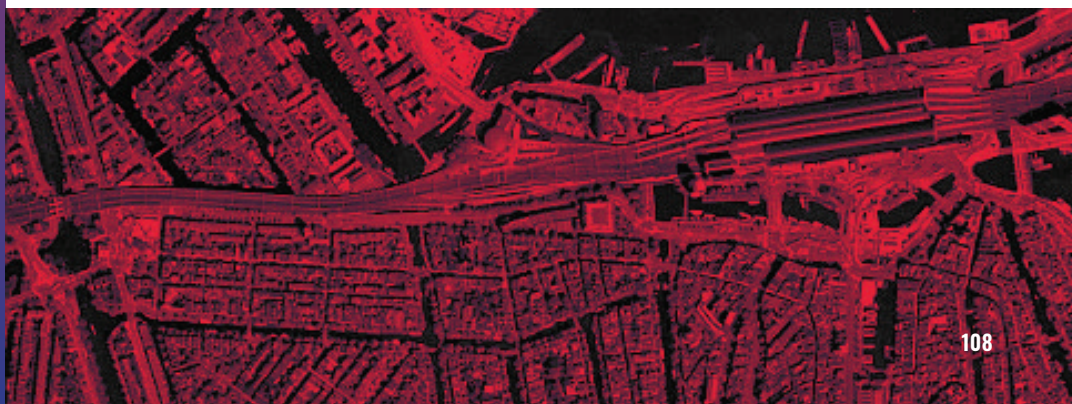
© Waag

What have been the highlights and lessons from your Fab City journey so far?

Various makerspaces have popped up throughout the city ever since Fab Lab Amsterdam opened its doors in 2007, and with our collective contributions to helping that network grow, our role within Amsterdam has changed considerably. As both cities and makerspaces continue to evolve, we're likely to see such spaces specialize: Some maker-spaces will focus on future research, while others will focus on product innovation, education, or small-scale production.

We've learned that showcase projects can play a critical role in creating ripple effects that impact entire neighborhoods, as well as establishing new methods for design. De Ceuvel, a project in the former industrial area of Amsterdam North, put into practice new ways of designing circular urban areas.

We've learned to accept that changing entire systems doesn't happen overnight. We've also learned the value of engaging with resistance and that we must the take the time necessary to establish the right frameworks and mind-sets.



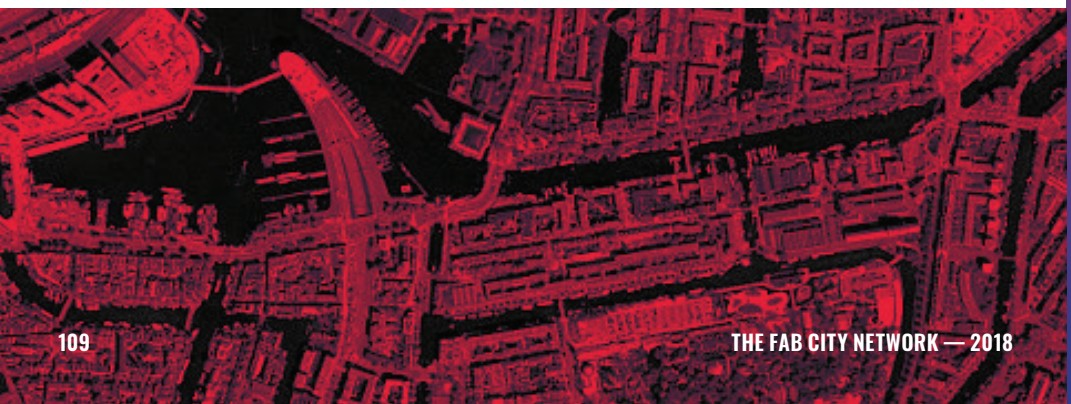
What is the current and future agenda of your Fab City activities?

Fab City Amsterdam is focussed on scaling up the decentralized urban manufacturing movement to become a major driver of the regional transition to a circular economy. Through our collaboration with the Amsterdam City Library network, we aim to provide residents with access to digital fabrication knowledge, infrastructure, and methods on the hyper-local level. In this way, we're helping ensure Amsterdam's future citizens are equipped with the skills and proactive mind-set that will be key to building a thriving city of tomorrow.

In terms of research, our project consortium is currently focussed on improving data collection and data quality in Amsterdam, while also looking at improving plastic recycling and circular building methods. In the future, we look forward to establishing a resource hub for reusable materials; building on existing resources to create a smart city dashboard for citizens and policy makers; making Amsterdam a hub for DIY biotechnology; and revolutionizing urban farming.

Strategic Focus:

Distributed manufacturing; synthetic biology; urban permaculture; distributed food production; education and learning; circular economy/doughnut economics; data commons; policy and governance; citizen engagement and grassroots innovation.

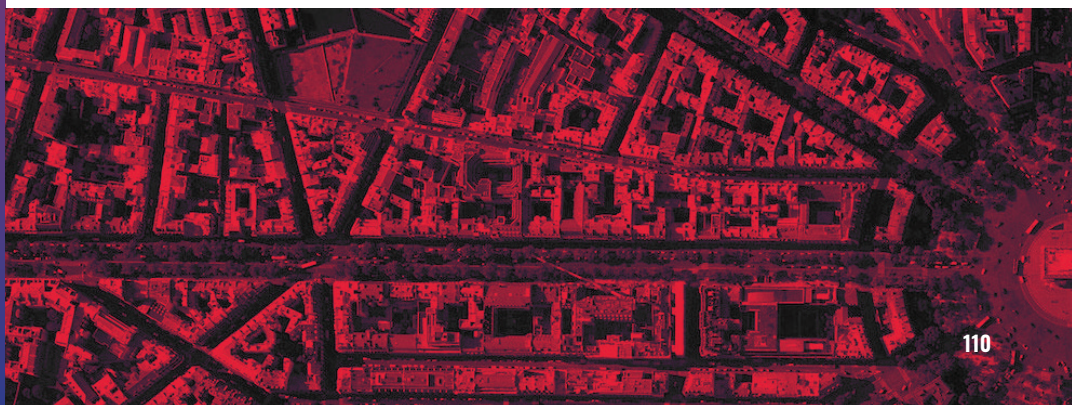


PARIS FRANCE

In the early 2010, the first hackerspaces, Fab Labs, makerspaces or neighborhood factories became visible in Paris and its suburbs. These open and collaborative factories, like all over the world, bring together designers, engineers, designers, DIYers, hobbyists and professionals around common projects and a territory. During this period, each place experimented with new ways of conceiving, cooperating, manufacturing and new forms of collective regulation. In 2013, this handful of actors proposed a first form of cooperation, the "SyndiCAD", with 3 simple ideas: organize cooperation between their activities, pool their ideas to explore and test the possibilities of technology as a powerful vector of society transformations for world global challenges. On July 4, 2016, when the Fab City Grand Paris barcamp was organized at The Arts Codés in the presence of Tomas Diez, the challenges and possibilities of the Fab City were already integrated by most participants of the workshop. This workshop gave birth to a map and a project, the association Fab City Grand Paris which was born on January 21, 2017.

What have been the highlights and lessons from your Fab City journey so far?

The Fab City journey is a long one. It has to balance between the interest of all the stakeholders, public institutions, citizens and makers expectations and industrials needs.



One of our great moments was the Fab City Bootcamp workshop during FAB13. This workshop was prepared by the Parisian team and proceeded by the Fab City Collective and especially with Fab City Brest. The result from the attendances was nice, they really try to establish the fab city vision in their city. The Fab City Summit in Paris is definitely one of them. Just the preparation of such event is a success itself.

What is the current and future agenda of your Fab City activities?

Studies and Prospects axis, three themes seem to be emerging.
A "macro / micro economy". From tools allowing the construction and analysis of fine economic data on a specific territory, how to promote the re-implantation of certain types of production. A "Logistics innovation". To develop Fab City and facilitate the passage of scale, logistics, flows are essential to our quest. A "Factory of the Future" theme in relation with the specialized Master Design by Data. Build by Bots.

Action / Animation Axis, also three themes:
An "Urban Agriculture". Carried by one of the actors of the Fab City Paris network, Sony Lab Sustainability, we will work all forms of urban agriculture in relation with the public at Parc de La Villette. A "Building together" collaboration with the program "Re-inventing" by the city of Paris. An "International Cooperation". Do and trust locally / think and develop globally, is in our DNA. We want to increase our international investment in European cooperation programs and of course actively involve ourselves in the Fab City Foundation.

Strategic Focus:

Distributed manufacturing; design decision-making; distributed energy production; artificial intelligence; synthetic biology; cryptocurrencies; urban permaculture; distributed food production; education and learning; circular economy/doughnut economics; data commons; standards and regulations; metrics; policy and governance/ownership; citizen engagement/grassroots innovation.

THIMPHU BHUTAN

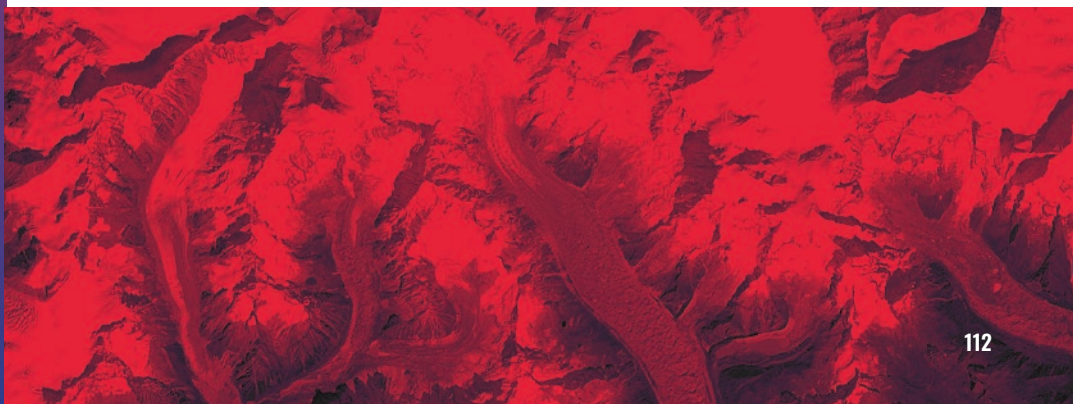
Fab City Bhutan's initial focus was on articulating an ecosystem of decentralised production throughout the country. The idea was to use social innovation and, particularly, disruptive technology to spread the decentralised production movement and put Bhutan on the path toward sustainability.

Fab City Bhutan's social significance and its potential to be a tool for change has not been lost on the country's policymakers. They've been quick to recognize in the project the same ethos that has long been the guiding principle of Bhutan's development strategy, which emphasizes a metric we coined, "Gross National Happiness," over Gross National Product. Fab City Bhutan embodies much of the spirit of the Gross National Happiness metric in its emphasis on building ecosystems, partnerships, and communities through cooperation, not competition.

The beauty of Fab City Bhutan is that it promotes a bottom-up approach to manufacturing and design, providing local makers the tools to hack products and adapt them to local circumstances. This inverted approach blurs the relationships between producers, suppliers, and consumers. It also has profound implications for supply chains, as well as for the organisation and content of work, which will in turn impact Bhutan's governance, regulation, education and social security.

What have been the highlights and lessons from your Fab City journey so far?

Fab City Bhutan has taken off, attracting a passionate community of makers, as well as favourable policymakers. Since our flagship Fab Lab



Bhutan opened its doors in 2017, it has garnered more than 6,000 registered users, with several more signing up daily.

The government has embraced our ethos, including our goal of shifting toward distributed digital manufacturing in the last of its so-called Five Year Development Plans, which runs from 2018 through 2022. We hope this will help Bhutan to make the leap away from a society driven by mass production and consumption and toward a society of "mass customization." This, in principle, will allow every Bhutanese citizen and business to customise the products and services they consume, produce and deliver. This new business model slashes waste and promotes personal satisfaction by enabling us to restructure manufacturing supply chains and completely reorganise our businesses and operations. It enables localised individualised production, attuned to specific local and user requirements and reduces environmental impacts, because products are produced in geographic proximity to where they're consumed.

What is the current and future agenda of your Fab City activities?

Our most pressing next step is to expand access by providing Fab Lab infrastructure throughout the country. We're confident our mobile Fab Lab will enable us to reach even further out, bringing access to 21st technology to even the country's furthest-flung rural villages. We're also working on developing machine-making-machine prototypes that will allow us duplicate our capacity and establish Fab Labs in 20 municipalities throughout Bhutan. We're also now expanding Fab Lab Bhutan to include the country's first Biological Fabrication Laboratory, or Bio Fab Lab, where we will focus on such living materials as fungi, genes, tissue cultures, bacteria algae, wastewater, plants and trees.

Strategic Focus:

Distributed manufacturing; design decision-making; artificial intelligence; synthetic biology; education and learning; policy and governance; citizen engagement and grassroots innovation.

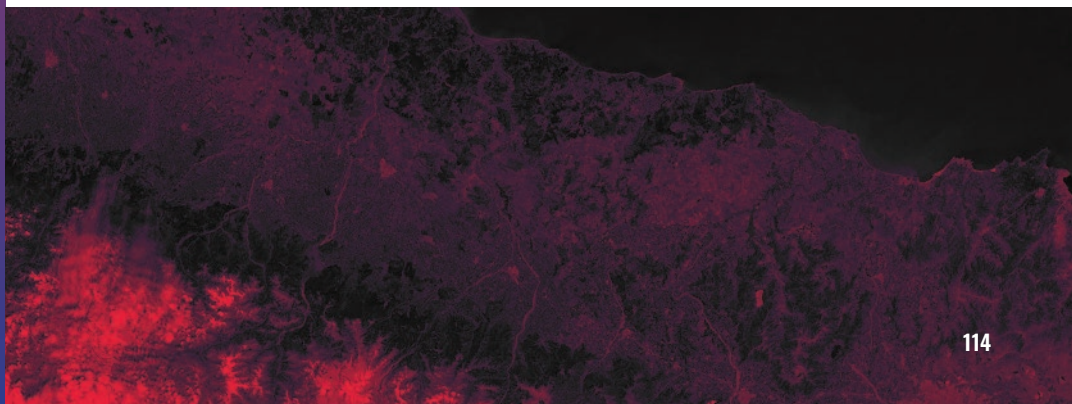
33°26'14"S 70° 39' 2W JOINED 2016

SANTIAGO CHILE

Chile's economic development model has relegated cities to the background, exposing them to the vagaries of neoliberal market practices that have led to social segregation and markedly low rates of community participation. While the capital, Santiago de Chile, is home to more than 7.5 million inhabitants, it's not even really a city proper but rather an unwieldy conglomerate made up of 37 communes. Each commune has its own mayor and generates its own income, resulting in a huge disparity between the richest and poorest communes. This system has also proven a major stumbling block to even basic governance, as there is no overarching authority able to implement projects throughout the city as a whole.

What have been the highlights and lessons from your Fab City journey so far?

In this first stage, we have detected two key lessons to canalize our cities into a new urban model.



The first one is that without any articulation of the ecosystem who takes decision over the city the project will not success, for this reason, we created different events in order to strengthen the ecosystem composed by public agencies, academia, private companies and civil organizations.

The second one, is that in order to change our urban model, citizens should have a critical approach over our cities and manage some basic concepts and tools.

What is the current and future agenda of your Fab City activities?

In this stage we are working in three different dimensions: articulation, education and project development. From these three dimensions we created a 5 months open and public Diploma in Design and Technological Innovation for Cities, where students got scholarships form the government to participate. After the second version with more than 400 applicants and 120 students, the next step forward is to incubate and accompany the development and implementation of the projects produced in the Diploma. In parallel we are implementing the Distributed Neighborhoods project which aims to create new urban infrastructures in local communities for resilience and market's autonomy.

Strategic Focus:

Distributed Design, Educational Programs, Circular Economy, Citizen engagements / grassroots innovation, design decision- making.

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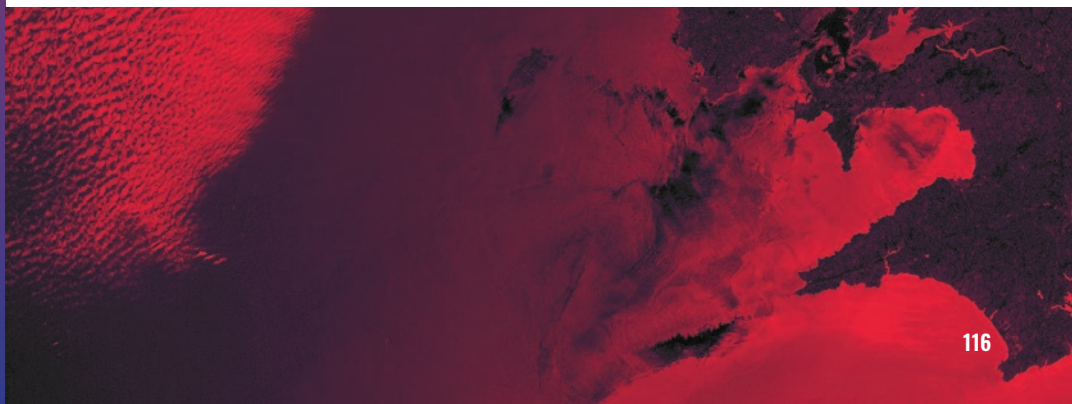
BREST FRANCE

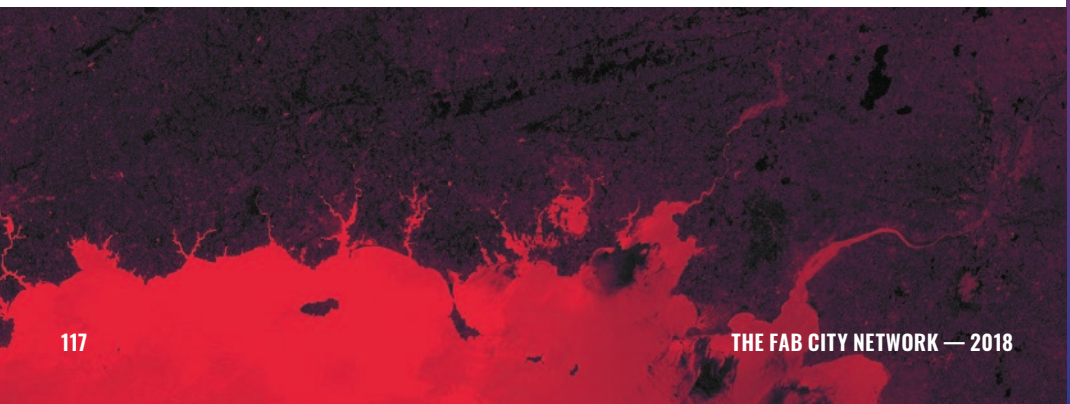
The history of Brest is deeply linked to its geography, as a seaside city perched on one of the westernmost tips of Europe. The port is both the heart of Brest and its lifeline, with much of the city's economic activity historically centred around the port and the sea. In more recent years, Brest has increasingly begun to look inland, with planning officials now taking into account the entire region, which is known as "le pays de Brest." The region consists of 89 communes, with roughly 400,000 inhabitants. Regional authorities are responsible for coordinating the territorial coherence scheme, tourism activities, high-speed networks, transportation, as well as coastal zones. Brest's universities and cultural institutions also cater to wider region, and are frequented by the 1 million-strong population of western Brittany. Brest is also home to an oceanographic research hub that's among the finest in the world.



For the past two decades, the city of Brest has been actively championing the development and democratization of digital know-how and skills. Digital tools have long been regarded here as crucial tools to help emancipate and empower local residents. Thanks to this long history of support, Brest is now widely regarded as a top-notch destination for digital mediation. Municipal authorities are focussed on helping the region navigate the challenges of the future, and officials have rolled out strategic documents to help steer future initiatives. Its local urbanism plan, known as "PLU facteur 4," covers planning for urbanism, housing, transportation, energy, and climate. The aim is to better integrate planning within these interconnected areas. Officials are also addressing the problem of waste management, setting the goal of transforming Brest into a "zero waste, zero garbage" community. Brest's economic development strategy is largely built around making the most of coming ecological, energetic and digital transitions. The city's digital strategy includes a project called "Brest collaborative and connected city" which explicitly sets the goal of working toward the Fab City objectives.

What have been the highlights and lessons from your Fab City journey so far?

In November, 2016, the Science Hack Day brought together people interested in working on a potential bid for the city. The hackathon gave rise to a public release in January 2017, which allowed to make known the approach to the city, and other actors became pillars in the project today. Presentation of the approach in Toulouse during the Fab Festival, which made it possible to realize that the group had approached the initiative by the prism of its context, by freeing itself from the problems of size and means city to impulse the dynamics. First connections with other cities closer in size and means. Times of exchanges and work at the UBO Open Factory, which allowed to

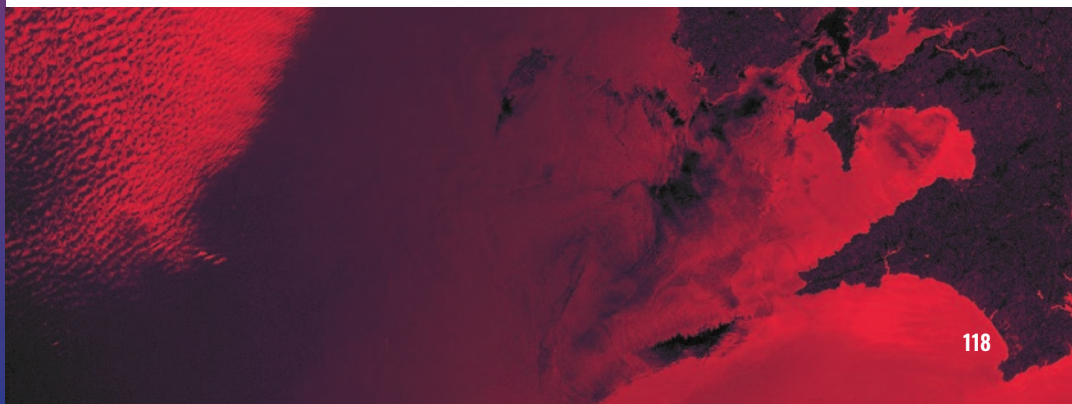


probe the soil of the key players, present or not. The workshop of July 8, 2017, just before the formalization of the city as Fab City. This day, led by Sylvie Kwayeb-Fagon, Collaborative Intelligence Facilitator, aimed to bring together the different actors and to approach the initiative through the project angle, in order to bring the initiative back on a less conceptual ground and more practical.Participation in Brest in Common, to connect the 3 major initiatives similar to Brest that are the Commons, Brest in Transition & Fab City Brest. The arrival of Thanh Nguyem and the establishment by the city of the first workshops animated around the project Fab City Brest, to unite the actors, and the awareness of the need, as in the beginning, to reclaim the discourse of the approach to adapt to the context (human, historical, sociological, political, economic ...) of Brest.

Your Future Fab City Strategy: What is the current and future agenda of your Fab City activities?

We're working on the formalization of the consortium of Brest, drafting the shared charter, which we will present to municipal officials to illustrate how the Fab City approach can be a lever for actions on the ground. The aim is to bring together the key players who can help us achieve our overall goals.

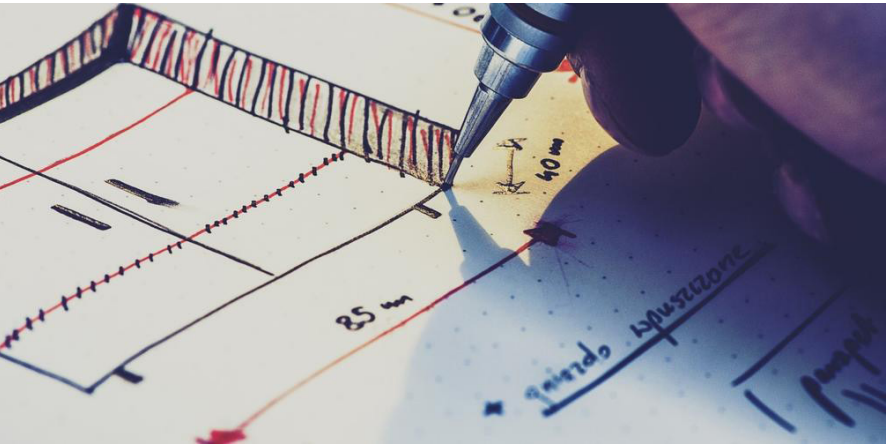
We will draw on our recent fieldwork, which brought us into contact with relevant municipal officials, as well as the community at large, during an upcoming forum on cooperative uses, scheduled for July, 2018. During the event, we'll present our plan for the city and exchange ideas with representatives of other cities. The forum will also include a workshop on territorial data and indicators, based on research work led by Jade Georis-Creuseveau and Cécile Guegan.



The city of Brest and the members of Fab City Brest project are also examining how to forge the strongest link between the forum and the Fab City Summit.

Which Strategic Focus areas are relative to your city?

Circular economy/doughnut economics; citizen engagement/ grassroots innovation; data commons; design decision-making; distributed food production; distributed manufacturing; education and learning.



CONSORTIUM MEMBERS PAGES 214–215

25°25'43"N 49°15'56"E JOINED 2016

CURITIBA
BRAZIL

The idea of joining the Fab City initiative came up along with other projects aimed at spurring innovation and entrepreneurship that were being implemented by Curitiba's City Hall. Those projects included the creation of makerspaces for public school students, as well as the so-called "Vale do Pinhão" which fosters the development of local start-ups. Municipal authorities rightly noted that the Fab City concept was in line with many of the principles guiding Curitiba's development strategy — namely, always regarding citizens as protagonists. Therefore, the city embraced the Fab City initiative as a way of strengthening the relationship with the citizenry, giving residents voice and initiative, and making them co-participants in the construction of a bottom-up urban model.

What have been the highlights and lessons from your Fab City journey so far?

The main focus of any city must be the citizens—and meeting their needs its most prescient task. By now, we've come to the realization that innovation without citizen involvement is pure folly. With this understanding, the challenge becomes drawing the citizenry into the process of co-creating the city, in order to best meet those needs. How to involve ordinary citizens in that process?

The good news is that in Curitiba, we have a whole range of stakeholders eager to collaborate on transitioning the metropolis into a Fab City. In fact, we've already embarked on collaborative projects with some of them. That said, we must still build new strategies in order to connect these stakeholders with the wider community, thus forging a stronger and more cohesive ecosystem, united behind the same goal.

What is the current and future agenda of your Fab City activities?

We're immersed in the planning phase, identifying stakeholders and mapping out possible projects aimed at furthering Fab City principles. After the conclusion of this phase, the next step will be to bring the various players together for a presentation of the Fab City project. After that, we will move to the prototyping phase, focussing on two neighbourhoods that have been selected for revitalization. We of course intend to carry out the prototyping process in close consultation with the community.

Strategic Focus:

Design decision-making; artificial intelligence; distributed food production; education and learning; data commons; policy and governance/ownership.

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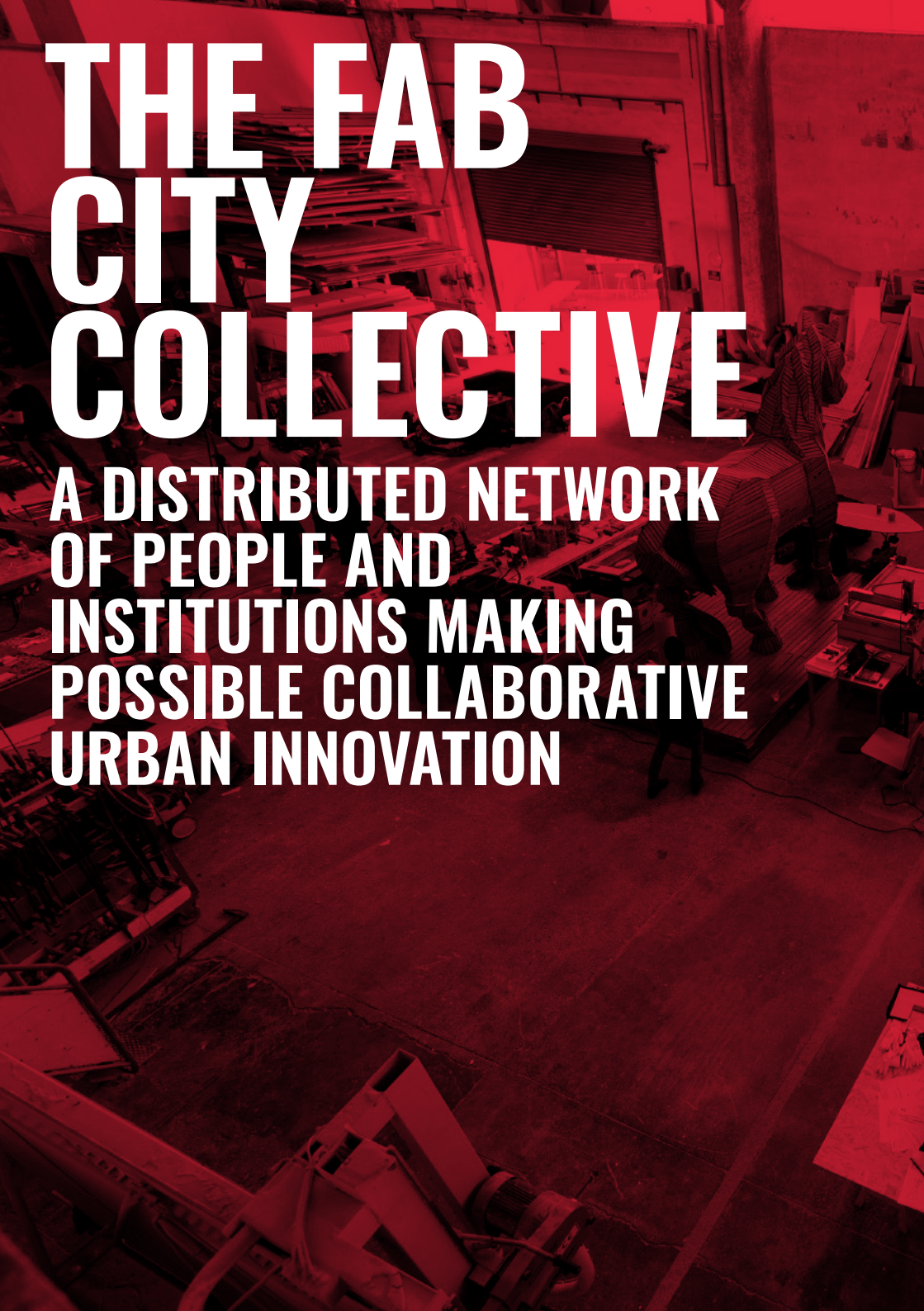


THE FAB CITY COLLECTIVE

A DISTRIBUTED NETWORK OF PEOPLE AND INSTITUTIONS MAKING POSSIBLE COLLABORATIVE URBAN INNOVATION

IS FUTURE MANUFACTURING OPEN SOURCE?

HOW REMODEL IS ENABLING NEW BUSINESS MODELS FOR COMPANIES

JULIE HJORT AND CHRISTIAN VILLUM

In the spring of 2016, Elon Musk's Tesla stopped enforcing their patents. Google, Facebook, Microsoft and IBM are also going open source with many hardware projects. All these developments point toward an emerging trend: The future of manufacturing appears to be going open source.

Moreover, it's not just large, powerful American technology companies at the forefront of open source as an emerging global megatrend in business. Startups and small- to medium-sized companies from all different industries and all over the world are creating new and exciting open source-based physical products. Companies like Ultimaker, Arduino and the British furniture firm Opendesk are just a few examples of how open source has become the foundation of some of the most innovative and interesting business models of our time.

An enabler for distributed manufacturing

Danish Design Centre has dived into this trend, which is part of the wider wave of technological disruption and digitization that's currently top of mind for many companies. It's also a trend with deep connections to the methodology and mindset of Fab City, Fab Labs and maker communities. Open source manufacturing has the potential to spearhead more democratic and distributed manufacturing ecosystems, as it allows for peer-to-peer-based innovation and casts business and customers as co-creators.

That's why we, in collaboration with a range of partners, created REMODEL, a design program allowing Danish manufacturing companies to explore and develop new business models based on open-source principles. The aim is to give the participating companies a strategic understanding of how to apply of open source principles in manufacturing, as well as how to bring those principles to bear on existing products.

A self-driven explorative design sprint

How can we craft a methodology that allows companies to explore open source and apply what they learn directly to their business, while at the same time keeping costs down and being respectful of their time?

That was the question that drove the design of REMODEL. It was quite clear we would have to keep things succinct and concrete, adhering to the design sprint format, as practiced for many years by designers around the world and later refined by Google Ventures.

To allow participating companies more flexibility, we decided to remix the format a bit, extending the program out over eight weeks and, crucially, decentralizing it, in order to let companies to take part from wherever they happened to be located.

REMODEL is set up to make participating companies fully self-driven. They receive a weekly work package with intuitive instructions, thus removing the need for instructors or designers to lead the process. The companies select a team of two to four employees, ideally including one person from top management, one person from the product development or innovation department, and one person from the manufacturing operations. After eight weeks of work together, the team should come away with two things: A strategic understanding of open source-principles and a draft open source- based strategy for their product.

Open sourcing hardware is complex

The ten companies' experience of the program has proved a source of major insights. Their experiences have made it increasingly apparent that open sourcing hardware is much more complicated than open sourcing software. These days, most physical products are made up of several non-physical elements, such as services, software or other virtual elements that are essential to the physical product without being a direct part of it. Take, for instance, online platforms, data streams, and even services, which may just as well be opened on top of, or even instead of, the hardware. But does that make the product itself open?

To answer this and similar questions and work systematically to build open sourcing business strategies, we incorporated earlier work by other top practitioners in the field. For instance, we included a reworked version the Open-o-meter tool, developed by the German and French national research foundations, which does an excellent job at defining what, exactly, what makes physical products open.

The secret sauce? The magic of building community

It's also becoming clear through the work of several of the companies that simply opening up single elements of the product does not actually measurably increase value creation. The real trick lies in the community-building aspect of the business strategy—namely, how to motivate users to engage with those open elements. The classic "build it and they will come" principle only goes so far in crafting a radically new business model. Rather, it's actually the social design of engagement that makes up the secret sauce. That's why REMODEL seized on "the system map," developed by Nicola Morelli of Aalborg University, as one of its core tools. It helps map capital flows, asset building, and human resources, along with other critical factors that companies need to address. It also maps how all these elements connect with one another. In essence, the tool allows users to visualize the entire system needed to develop, manufacture, and sell the product, identifying all the necessary elements and how they're interrelated. As part of the REMODEL program, we've also added a feature that identifies which of these elements could be open sourced in order to optimize value creation. Systems mapping makes sense because it prompts companies to consider the relationship between the open elements and the users, and also ask the right questions.

For instance, what kind of channels or platforms need to be set up, or found elsewhere, to enable meaningful knowledge and idea exchange, as well as concrete co-creation activities? And how do we get people to understand the opportunities now being made possible and engage with them?

You can do it, too

As we write this, the 10 manufacturing companies taking part in REMODEL are close to finalizing their open source business idea, meaning that there's still lots for us to learn, explore, improve, and share.

But this learning process is not limited to our participating companies. The REMODEL design sprint methodology is freely available and openly licensed under a Creative Commons BY-SA license, which invites anyone to rework it, build on it and use it even for commercial ventures, provided they give as credit to the Danish Design Centre and the other creators whose work we built on.

You can find all the REMODEL materials on Github (https://github.com/RE-MODEL). A more polished REMODEL Toolkit will be published in October, 2018.

Companies participated in REMODEL:

Stykka, Grundfos, Outsider, Novozymes, Thürmer Tools, Kinetic Mobiles Copenhagen, Lindholm & Husum, TagTomat, Tekpartner & Sitpack.

DESIGN GLOBALLY, MANUFACTURE LOCALLY

NEW INDUSTRIAL CONFIGURATIONS LEADING TO A CULTURAL PHENOMENON[1]

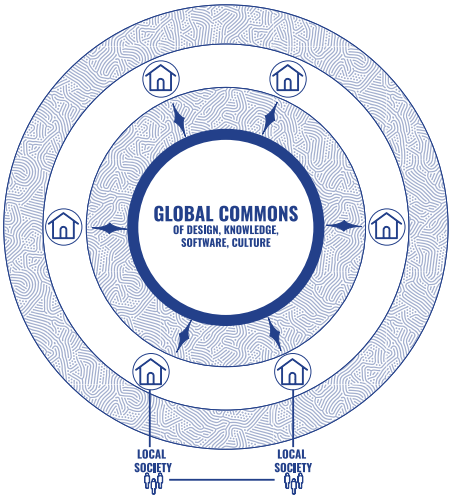
VASILIS KOSTAKIS
JOSE RAMOS
VASILIS NIAROS

1 This article is a reworked version of Kostakis & Ramos, 2017.
2 https://openbionics.org/
3 http://www.latelierpaysan.org/
4 http://farmhack.org/tools

→ See the page **104** to know more about the project in Amsterdam

What if globally designed products could radically change how we work, produce and consume? Various examples taken from several continents demonstrate that the way we are producing and consuming goods could be improved by relying on globally shared digital resources, such as design, knowledge, and software.

Imagine a prosthetic hand designed by a community of scientists, designers, and enthusiasts from across the globe. Imagine that all the knowledge, software, and designs necessary for making such a sophisticated piece of hardware were shared, across the width and breadth of the planet, as a digital commons. It's already a reality. At least in principle, anyone from anywhere in the world who has an Internet connection and access to local manufacturing machines, including things such as 3D printers, CNC machines, and low-tech crafts and tools, can, with the help of an expert, manufacture a customised hand. This perhaps surprising fact forms the intellectual framework of the OpenBionics[2] project, which produces open-source designs for affordable and lightweight robotic and bionic devices. It's a model with considerable advantages. Firstly, there are no patent costs to pay for. Less transportation of materials is needed, since a considerable part of the manufacturing takes place locally; maintenance is easier; and products are designed to last, thus bringing costs down dramatically (Kostakis *et al.*, 2018).



Design is developed as a global digital commons, whereas the manufacturing takes place locally, often through shared infrastructures. Source: Vasilis Kostakis & Nikos Exarchopoulos.

Take, for example, small-scale farmers who rely on agricultural machines to support their work. Big companies rarely produce machines for small-scale farming. And when they do, the maintenance costs are high. Small-scale farmers are forced to adjust their farming techniques, and their way of life, to the logic of the machines, instead of vice-versa. A community of such farmers in France is now avoiding many of those pitfalls by designing and manufacturing their own agricultural machines. The community shares its designs with the world as a digital commons. Another community of small-scale farmers from the U.S. has been facing similar challenges and has struck on the same response. These two communities—the French co-operative L'Atelier Paysan[3] and

the FarmHack[4] network from the U.S.—have since connected and are now creating new synergies by contributing to the same digital commons (Giotitsas & Ramos, 2017). With our colleagues, we've been exploring the contours of an emerging mode of production that builds on the confluence of the digital commons of knowledge, software, and design with local manufacturing technologies. We call this model "design global, manufacture local," or DGML, and maintain that it could lead to sustainable and inclusive forms of production and consumption (Kostakis *et al.*, 2015). It's only logical that light things like knowledge and design go global, while heavy elements, like manufacturing, remain local, and, ideally, are shared. Decentralised open resources for designs can be used for a wide variety of things, such as medicines, furniture, prosthetic devices, farm tools, machinery, and so on. Take, for concrete example, the Wikihouse[5] community that produces designs for houses; the LibreSpace[6] community that built the first open source satellite in orbit; or the RepRap[7] community, which creates 3D printers that can self replicate. Around such digital commons we are also observing the emergence of new, commons-based, entrepreneurial ecosystems. The profit motive is not totally absent but it's relegated to the margins.

Finding sustainability

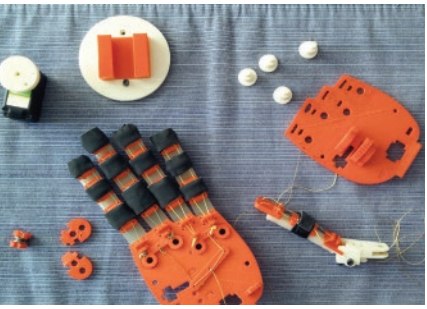
How are these projects funded? Commons-oriented projects are experimenting with various business models to remain sustainable, including government funding in the form of research grants, individual donations via crowdfunding, and establishing alliances with established firms and institutions. These globally connected, local, open design communities do not tend to practice planned obsolescence. They can adapt such artefacts to local contexts and can benefit from mutual learning. That means that Ecuadorian mountain people can, for example, connect with Nepalese mountain farmers to share knowledge and learn from one another, thus sidestepping potential dependency on proprietary knowledge controlled by multinational corporations.

Towards 'cosmolocalism'

This idea comes partly from discourse on cosmopolitanism (see Kleingeld & Brown, 2013) that asserts that all human beings belong to a single community, based on shared morality and a shared future. Cosmolocalism captures the potential of the global digital commons, in conjunction

5 https://wikihouse.cc/
6 https://libre.space/
7 http://reprap.org/
8 https://stopresetgo.org/

with the capacity for more localized manufacturing. The shared morality comes through commoning, which essentially boils down to co-creating and co-managing a shared resource. The dominant economic system treats physical resources as if they were infinite, even as it holds tightly onto intellectual resources, as if they were finite. But, in reality, it's quite the contrary. We live in a world where physical resources are limited (Ahmed, 2017), while non-material resources are digitally reproducible and, therefore, can be shared at a very low cost. Moving electrons around the world has a smaller ecological footprint than moving coal, iron, plastic, or any other material. At a local level, the challenge is to develop economic systems that can draw from local supply chains. Imagine an urban water crisis in a city so severe that it threatens to affect a whole city within the space of a single year. A cosmolocal strategy would mean that globally distributed networks would activate to solve the issue. In one part of the world, a water filtration system would be prototyped. The system itself would be based on a freely available digital design that can be 3D printed. This is not fiction. There is actually a network based in Cape Town, called STOP RESET GO[8], that aims to hold a cosmolocalisation design event where people would collaborate intensely to come up with the solutions for just such problems. The Cape Town STOP RESET GO teams are already using such an approach to experiment with the challenges that crop up in their daily lives. To make the system work for them, they have to make modifications, which they duly document and include in the next version of the open design. Now, other people around the world are using these new iterations and applying them to their own challenges.



Limitations and future research

One limitation of this new model lies in its two main pillars, information and communication, as well as local manufacturing technologies. These issues may pertain to resource extraction (De Decker, 2014), exploitative labour (Fuchs, 2016), energy use or material flows (De Decker, 2015).

A thorough evaluation of such products and practices would need to take place from a political ecology perspective. For example, what is the ecological footprint of a product that has been globally designed and locally manufactured? Also, to what degree do the users of such a product feel in control of the technology and knowledge necessary for its use and manipulation? Some answers to the questions above will help us in understanding the transition dynamics of such an emerging mode of production better.

FAB CITY BERLIN 2018
WORK IN PROGRESS
DANIEL HELTZEL

The spark that lit the fire of Berlin's Fab City experience took place in 2015, when the Berlin-based think-tank Open State Strategies co-produced, along with Oui Share, the Transition Camp POC21. With its demonstrators of products that could be produced and consumed in a "fossil free, zero waste society," the camp in some way laid the groundwork for Berlin to become a Fab City. The team came back fired up, with plenty of ideas and a burning desire to put them into place. They teamed up with local partners to help facilitate the roll out, which was a major objective of a related proposal for the European Union-sponsored H2020 program in 2017. After all, if open-source, sustainable products are really to become the "new normal" in Berlin, they'd obviously have to be manufactured somewhere.

We at Fab Lab Berlin were happy to join the Berlin initiative in early 2017, bringing to the table our expertise in product design, prototyping and matchmaking with manufacturers in the metropolitan area of Berlin. The network included partners such as CRCLR, a hub for circular practices, and Fraunhofer IZM, a cutting-edge research institute that provides support in rethinking consumer electronics and electrical components to be used as part of Smart City solutions.

We decided to start with outlining a socio-economic profile of the area, highlighting not only the city-specific challenges we wanted to address, but also enumerating the potentials which we thought could facilitate the production and distribution of novel solutions. The challenges we identified, in consultation with the municipal government, included the integration of refugees into the regional labour market; the utilization of peripheral and central public property through a well-balanced multi-purpose use; and social integration along parameters such as age, employment, education, gender, and ethnic background in a bid to counteract the growing phenomenon of social stratification. And in our search for opportunities for Fab City-related practices, we immediately honed in on two: first, the undeniable boom in hardware-consuming industries, such as arts and entertainment and accommodation and housing; and secondly, Berlin's already-rich ecosystem of singular stake-holders working on Fab City-like projects, which made it more important to connect the existing dots in than try to merely create new ones. Our idea was to build an umbrella network aimed at helping the various actors channel their endeavours into larger, scalable projects, closely coordi-nated with the city administration.

A view into CRCLR, a hub for circular practices in Neukölln.

In the end, we set the goal of "increasing the visibility, credibility, and economic traction of ecologically more sustainable and socially more inclusive practices of production and production-related education in Berlin." We would "support public long-term demonstration spaces, such as district libraries and shelters for asylum-seekers, as well as similar business models in accessible industries, including gastronomy, entertainment and the built industry." For the actual execution, we laid out a three-pronged approach: learn and rethink; demonstrate and produce; improve and scale.

Looking back, the plan feels consistent and adequate. And yet, we've still not been able to fully achieve it. Our Fab City Berlin-undertaking requires public funding to kick off, and we were unable to secure either European Union or German funds. As the title of this article plainly states, it's work in progress. What's more, we recognize that our way of orchestrating our efforts with public stakeholders could have been more efficient—and that will be our focus over the coming months. Seeing that the city is planning to install a lab/think tank for Smart City solutions called the CityLAB, we expect momentum to build over the coming years.

PHASE	TASKS	TARGET GROUPS
LEARN & RETHINK	• Circular edutainment & leadership retreats • Circular product development • Circular business models	• Public • Students • Executives
DEMOSTRATE & PRODUCE	• Equipping public spaces • Low-tech production in selected industries • Production management	• Public • Entrepreneurs
IMPROVE & SCALE	• Evaluation • Fine-tuning • Company building	• Entrepreneurs

POC21 Camp

Summing up, at this stage it's safe to say that Berlin is in a good position to evolve into an increasingly relevant Fab City—meaning a metropolis in which consumption of goods is no longer so independent from its production, but rather increasingly connected, for the sake of both the environment and society. Many of the Responsible Research and Innovation projects that we, and our partners in Berlin, are currently pursuing are in tune with that overarching goal. While they've not yet been fully orchestrated, I personally remain convinced that public procurement could offer legitimate and feasible leverage for slightly scaling and channelling Fab City-related operations, if approached systematically.

After all, why shouldn't the government include requirements like "co-created" and "locally produced" into procurement calls? Take, for example, a public library that needs to be build and equipped: By utilizing the latest digital fabrication tools and know-how, most of it could be produced in the city of Berlin itself—whether you're talking about components for built structures, furniture, or even electrical components. We're also looking into involving business schools to help refine the business modelling and the CityLAB to identify suitable public procurement opportunities. I'm looking forward to promoting this topic with my team in the near future!

DESIGN FOR TRANSFORMATION

REVOLUTION THROUGH COLLABORATION

KAREN VAN DER MOOLEN

There seems to be a growing general acknowledgement—finally!—of the need to save the planet, to get a grip on mass migration, to rethink how value is distributed across the globe, and, in short, basically to change our ways as a species. However, although we are increasingly seeing the overarching need to do things differently, it doesn't necessarily follow that we're adapting seamlessly to a changing future, or even that we agree upon what that future looks like. Our personal habits and preferences, current opportunities and perceived limitations, and, of course, our local cultures all colour the way we operate today. We now agree we cannot keep on with business as usual, but, even so, changing our ways remains so damn difficult.

→ See the page 104 to know more about the project in Amsterdam

Fab City promises a new urban model where citizens are empowered to master their own destiny. It aims to enable the development of resilient and sustainable cities and city life. Still, we mustn't fail to recognize that we are still an inherent part of the old systems that we're trying to change. After all, the majority of our current workforce was born, raised and educated in a non-digital world and still remembers what it was like to not be connected. So where do we start? What first steps can we take? How do we prepare ourselves not to be devoured by new systems but rather to take ownership of them? How do we create movement? For ten years, Waag has been home to Fab Lab Amsterdam. Guided by the values of fairness, openness and inclusivity, Waag operates at the intersection of science, technology and the arts, focusing on technology as an instrument of social change. Here are some insights from our over 20 years in the field.

Zoom in on specific industries

For years, we used the Fab Lab as a tool to develop our own projects and prototypes, and on our so-called open days, we acted as facilitators, helping others to develop their own work. Through programmes like the Open Design Contest, we taught design students about the principles of iterative design, ownership and creative commons. By providing these programmes, we came to understand the complexity of the goods we use daily and, what's more, came to realize how very little we knew about them. Through our explorations, questions of ownership arose. We knew not to open products up or the warranty would expire, but we came to understand that if you don't open a device, you don't own it. Those realizations led to our first quest: an awareness campaign on consumer electronics called Fairphone. We took the principles of fair, open and inclusive design and tried to open up the mobile phone device; beyond that, we were eager to open up the complete production chain all the way up to the raw materials, some of which were mined in Congo. We wanted to make people aware of the circuitous route their phone had taken before ending up in their hands. At the outset, we could have never imagined that Fairphone would become an actual product—the world's first fair mobile phone. But it did. Fairphone was our first example of how a maker mind-set, combined with a deep understanding of a specific industry, can be the start of a revolution.

In our current programmes addressing the textile industry, biotechnology and education we go one step further. Combining the Fab Lab with industry-specific tools and machinery, we added a Textile Lab and Wet Lab to our facilities. The key researchers operating these labs have a thorough understanding of the industry they're dealing with and know how to

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operate the Fab Lab. The combination of industry-specific knowledge, vocabularies and skills on the one hand and a deep understanding of digital and bio-fabrication, open design and commons on the other provide Waag with an indispensable basis for transforming our old ways into new, future-proof systems. With the specific combination of knowledge and skills, we can build bridges.

We also hold intensive, expert academy programmes, to which we invite social innovators and creative and critical thinkers who are able to make connections between disciplines to really master material and electronics fabrication, textile and biohacking. But above all, we invite them to wonder again: to build networks, adapt to new contexts, to trust their intuition. They zoom in on a specific part of their industry, experimenting and researching hands-on how they can make a difference, one step at a time. And while we are at it, we learn a lot from our students, too.

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Seek for change agents

Over the years, we worked with different industrial players and sectors—from banks and industrial suppliers to healthcare and education—to investigate how a maker mind-set could benefit them. We came to see that the change agents within an organization are often not its decision makers. It turns out that it's not about taking leadership but rather allowing others to change direction. We've learned, therefore, to seek out the change agents within the organisations we work with.

A beautiful example of the phenomenon is our work with the Amsterdam Public Library. Like many libraries across the world, the public library of Amsterdam needed to reinvent itself: With the digital ubiquity of information, libraries have been forced to rethink their roles in society. Increas-

ingly, libraries are engaging in active knowledge construction through the act of making, rather than the pure transfer of knowledge through books and other traditional media. Their aim: to provide access to the knowledge of modern technology, open hardware, open software and maker practice to the public at large—the young, the elderly, you name it—through practice. A big challenge lays in the fact that traditional librarians tend not to be too familiar with digital fabrication or maker pedagogy, just as many teachers in formal learning environments are also largely unfamiliar with these fields. The librarians needed to adapt to the library's new role.

We developed library maker camps, accessible to all library employees. Through a low entry-level programme, we built their confidence working with electronics and digital fabrication tools. But, perhaps even more importantly at this early stage, we took the time to develop their creative and collaborative mind-sets. Often in just two short days, many embrace the opportunities provided to grow and excel—regardless of age, gender or social background. The camps were designed less with the goal of delivering experts in digital fabrication than in identifying change agents within the organisation.

To us the strategy is clear: Change cannot be imposed from outside or from top-down. You need major decision makers to sign off on the deal, but if you want actual movement, you need the commitment, passion and ambition of individuals throughout the organisation. People who are valued by their peers will often show the personal drive to hold on and push through when things get tough—provided they're properly facilitated. If they're provided with a safe space to try and fail, they'll be an inspiration to others, many of whom will in turn often end up joining the movement.

Upgrade their skills and deepen knowledge (and your own)

Over the years, we've found ourselves more and more focused on training and coaching: the librarian maker camps, teacher maker camps, museum camps, innovation boot camps and textile and bio hack academies. Critical making and critical thinking are hot, and yet you're not going to learn it in school, at least not just yet.

Educational systems in most countries have not changed much over the past 40 years or so. What our children learn today is not that much different from what was taught back then, despite the salient and pressing fact that they will, of course, be the

professionals of the future. They will be the citizens of these resilient, sustainable, inclusive cities. Part of the issue is the frenetic pace of change. For example, even if we now offer 3D printing courses in teacher training, by the time teachers have finished their training, the next big technology has already been announced. Technological development simply goes too fast. That means we need to radically change our attitudes and approaches toward teaching and learning in order to prepare for a future that feels almost fluid.

That's why in maker camps we allow professionals to become students again. We allow them to experience what it's like to live and learn in the 21st century, so they will be better equipped to teach in the 21st century. We incorporate the same type of pedagogy and experience-based learning as the celebrated Danish creative business school, Kaospilot.

We help our students develop a maker mind-set—a mind-set that allows us to be experimental and fearless, yet at the same time critical, flexible, hands-on, and sensitive to others' viewpoints, open to having our assumptions challenged and, most crucially, optimistic.

Still, we recognize that it's not simply pushing everybody to do a whatever-your-profession-is-maker-camp that will make a difference. What happens afterward is even more important. Through the roll out of a complete city infrastructure of library makerspaces, ambassador and fellowship programmes, maker mornings, textile dialogue evenings, we facilitate our students to keep moving, establish their own rhythm, self direct their learning and teach others.

Embrace Resistance

Our transformation journey is not a smooth and happy story all the time. We have faced criticism and even cynical push back along the way. Before we discuss the future with anyone, it does help to take a step back and consider our own mind-sets. Working in innovation, our eyes are on the future. This is both our strength and our biggest weakness when it comes to impact and societal transformation.

Our primary impulse might be to start conversations with like-minded people and gain traction to start with the first movers, but we certainly mustn't disengage from those who resist. Creating movement is not about trying to convince others that you're right, but thoroughly understanding what's holding them back. When you allow yourself to go deep, it can often open a doorway to a tremendous amount of insight. We might feel that it slows us down, but no one ever said change was quick or easy. We must embrace resistance. We start from the premise that every person is naturally resourceful, creative and whole. If an individual seems unable to engage, chances are that there are internal and/or external restrictions limiting them. It is in this resistance that we often find energy and opportunity.

Concluding remarks

Thanks, in large part, to technological development, society has become increasingly complex. We have built up our systems over the course of decades and embraced the use of technology of all sorts of shapes and sizes. In our search for societal transformation we need to zoom in and unravel this complexity. We need to enable change agents to rework their specific industries and sectors, step by step, and allow individuals to make a difference. By contrast, approaching systems or organisations as a whole will have a paralysing effect on our ability to create actual change.

It's not the machines that make the difference. It's the mind-set of the people who use them. It's not individual expertise, but the ability to collaborate, to be critical, to combine knowledge, techniques and tools. It's not the individual solution to a problem that makes the difference, it's the opportunity to share solutions, to iterate and localize. It's not about the end result, but putting the right processes in place. It's not about showing what you know, but seeing what you don't know. It's not about taking leadership, but allowing others to change direction. It's not about pushing forward, but about enabling movement.

If we want to design for sustainable, inclusive systems, we must call on our peer social innovators and everyone who cares to take the time to establish the right frameworks, mind-sets and dynamics. To engage with resistance, keep listening and make sure everyone is on board for the ride—no matter how fast we'd like to go. Revolution will happen through collaboration.

TEN YEARS OF PAKHUIS DE ZWIJGER / AMSTERDAM

FROM SQUAT TO INTERNATIONAL INDEPENDENT PLATFORM FOR CITY MAKERS

EGBERT FRANSEN

It started off as a slow train, but after ten years, Pakhuis de Zwijger is now on a fast track. The organisation, housed in its distinguished location at the IJ, has made a name for itself throughout the Netherlands and also won international acclaim. Here's a look back—and forward—with founders Egbert Fransen and Hester Tiggeloven.

→ See the page 104 to know more about the project in Amsterdam

"It's hard to imagine that we managed to get things moving in the way we did. We started from scratch." Ten years ago, Egbert Fransen and his partner Hester Tiggeloven were still running Cultuurfabriek, which produced large-scale change events for corporations, NGOs, and government ministries, as well as organizing the Over het IJ summer theatre festival in Amsterdam-Noord. But Fransen had long harboured other, bigger dreams—of a space that would host corporate and private events by day, and cultural and political programmes by night.

"It was something we wanted, and we were offered opportunities before," he recalled, "but those fell through for several reasons. Besides, we wanted to run our own space."

Through a potent cocktail of vision and luck, they were able to obtain a building at the River IJ and, after some renovations, immediately went to work, renting out spaces, connecting people, and producing cultural events. Tiggeloven cast her mind back to the early days: "We started organizing get-together with people from our networks, showing them the renovation of the building. It was a joint venture with Paul Morel from Stadsherstel Amsterdam, which still owns the building. Our tradition of the 'Tafel van 50,' a dinner with 50 guests seated at one long table, started there, with people eating mustard soup and salads in the building, which was still under construction."

In the beginning, there was no money, no real business plan, no partners, no funding—just a building, lots of ambition and ideas, as well as a large network. Soon, we started programming weekly events at night: "Women Inc.," "Groove Nights," and "Beamlab," as well as others that are still going, such as "What's Up?" and "Talk of the Town"—which hinted at Fransen's growing focus on the city. "I was inspired by Richard Florida's book and his vision for the city. He mentioned the relationship between the success of cities and the development of a blooming creative industry. For me, that was an eye-opener and a very interesting idea." Amsterdam,

he felt, needed a place for the creative industry to come together. “At the same time, I was also trying to come up with an alternative to the traditional debate stages—something more practical, with more imagination, and dialogue instead of never-ending discussions.” Tiggeloven added, “We were looking for sustainability. We were tired of incidental meetings: We wanted to create something with lasting impact.’

In the run-up to Pakhuis de Zwijger’s fifth anniversary, in 2011, the team of programme-makers organised twenty so-called “Tafels van 5.” ‘We invited people from our network—with different backgrounds—for a five-course dinner, served over five hours, and asked them what they were currently working on, about their visions for the near future, how they could contribute to that future, and how we could collaborate with people and organisations in our city.”

It led to the spin-off Fransen had been hoping for: “We constructed a manifesto called VOOR AMSTERDAM and printed it on the back of a magazine made by visiting students of ArtEZ, in Arnhem. It consisted of ten points, of which learning and exchanging were the most important. Furthermore, the idea for City Embassies was born at the table of the people we invited from Rotterdam. Soon after, we met again in their hometown and set up our first City Embassy, immediately followed by another one in Berlin.”

The timing was perfect: Both the Internet and digitalisation were accelerating, and in the wake of the financial crisis, much was in flux. Existing institutions were either collapsing or struggling with societal transformation, and in the void, interesting bottom-up initiatives and platforms were arising. People were moved by a potent need to come together. “We gave these movements visibility and a platform for sharing information, stories, and experiences.” Projects like “Nieuw Amsterdam - Stad in Transitie” were born, shaping the momentum of transition. It catapulted Pakhuis de Zwijger into a leading role in the field of urban transition, organising programmes about future smart cities and climate change. Fransen explains the “kick-and-run mentality” of the place: “Every time a ball lands in front of your feet, you kick it forward as hard as you can while shouting ‘come on, let’s get it!’ and making people follow you. It’s about putting marks on the horizon.”

Over the following five years, the network of collaborators and partners grew exponentially. Now, weeknight events reliably draw hundreds of visitors every night. Most of the events are free, to ensure everyone has a chance to become informed and join the dialogue. During the day, rooms are packed with corporate or private events. Teamwork is key, said Tiggeloven. “Success is built on a flexible and extremely professional organisation and dedicated programme-makers. It is truly a well-oiled machine, capable of producing all kinds of happenings with the same

standard of quality, including book presentations, corporate congresses, smart city conferences, and creative gatherings for social start-ups."

A measure of pride is definitely in order, as Pakhuis de Zwijger is now an established brand, making a palpable impact through its City Makers and Urban Agenda. To Fransen, it's been a fascinating experience. "Wherever I go, people know us now. And when we invite people to join one of our programmes, everyone gladly accepts, whether it's a designer, a director-general, or an alderman." And on the rare occasions when Tiggeloven takes a cab to work, she needn't do more than mention the name of Pakhuis de Zwijger. No further explanations are necessary. "As someone born and bred in Amsterdam, I have to confess this makes me proud," she said.

And it's not just folks from Amsterdam. Pakhuis de Zwijger has gone international—with over 120,000 online members, and counting—thanks to the city's growing influx of immigrants, expats, foreign students, and tourists. The programmes are crossing borders too, with offerings like "(New) Urban Agenda," "City Embassies" in different capitals, and the "Quito UN Habitat III." At the moment, about a third of the programmes in Pakhuis de Zwijger are conducted in English. "It is great to see we're having an impact on the city," Fransen said. "We have people getting inspired here and starting their own programming initiatives. That's great, but it also means we have to be on the lookout, we have to keep distinguishing ourselves, maintaining our communities and finding new ones. Our cities are facing a lot of new issues, such as diversity, incorporating digitalisation in our society, the balance between tourism and liveability, and governance and democracy. The next ten years will prove crucial in determining how cities deal with the public domain, in the broadest sense of the word. Who owns the city—the water, energy, clean air, transport, technology, houses, and data? And will we be able to include everyone, or will there be deep divisions?'

Pakhuis de Zwijger aims to keep playing an important and even leading role in dealing with these urban issues, without taking sides. "We are pragmatic idealists, not activists," said Fransen. "We want to include everyone: corporate folks, as well as municipalities, insurance companies, politicians, citizens, students, designers, creative types, and scientists.

It's the so-called Amsterdam Approach, the multi-stakeholder approach that won the iCapital Award in 2016-2017. And people must feel they can speak out freely, because that's what makes for interesting discussions." Both partners love the vibe in the building, which can be incredible, according to Fransen. "The other night, we had a full house. A 'Tegenlicht MeetUp' about robotics had 350 people in the audience, and another 140 people were in another room discussing healthy ageing, as well as 80 more in the Studio, discussing newcomers and affordable housing. And there was also a private event going on, organised by a law firm. At the square in front of the building, people who attended events during the day were having a drink, while others were dining in the restaurant before the start of an evening programme. The place was bursting with a great diversity of people, without any dominant groups. At these moments, we are extremely proud."

If this all sounds too good to be true, in a sense, it is. Even so, the overwhelming appreciation society and governments have shown for Pakhuis de Zwijger has not yet translated into financial support. Trying to get structural funding has proven very difficult, as the organization defies easy labels and doesn't fit into the existing structures of cultural funding. Its success has also been used against it: Potential backers often say that because the space is so popular and can hold its own, financially, it doesn't need funds. At the moment, 90 % of Pakhuis de Zwijger's income comes from its own activities, although Fransen would like to work toward securing 30 % of structural funding from the city and national governments. The idea, he said, is to "create public space for research and development. Right now, we have to push our boundaries too far. It's an unhealthy situation."

The couple has its work cut out for the next ten years. "We're at a point where we have to try to sustain what we have built up so far," Tiggelhoven said. "This whole thing has grown much bigger than us."

"Our main goal was and is to bring people together, exchanging know-how and creating an impact together," Fransen concluded. "For now, this is the best place to do just that. This level of energy, engagement and connection is hard to find anywhere else."

A Key Fab City Enabler: Fab City Campus Amsterdam and iCapital

In early April, 2016, a temporary and freely accessible Fab City Campus was built at the head of Amsterdam's Java Island, in the city's Eastern Harbour District. The campus was set up as part of Europe by People, the Amsterdam EU2016 Arts & Design programme and was inspired by the Fab City project.

Conceived as a green, self-sustaining city, the Fab City Campus was made up of some 50 innovative pavilions, installations, and prototypes. More than 400 young students, professionals, artists, and other creative types developed the site into a sustainable urban area, where they were able to work, create, explore, and present their solutions to current urban issues. The participants came from a variety of educational backgrounds, having attended art academies, universities specialized in technology, as well as vocational colleges. Amsterdam joined the Fab City initiative in the FAB12 international event in Shenzhen, China.

Fab City Campus took place from April 11-June 26, 2016. It was inhabited by students, scientists, and social entrepreneurs, and also functioned as a big makerspace: a place to collectively experiment, prototype and test new ways of improving the cities of the future. It consisted of several pavilions showcasing different innovative ideas for the connected, self-sufficient, and circular city, including the cardboard Wikkelhouse, by Fiction Factory, and the BAM 3D concrete printer. At the same time, Amsterdam was awarded the iCapital Award 2016 / 2017 - Innovation Capital of Europe – along with Barcelona.

Amsterdam was also the site of the first Fab City Summit, an expert meeting that brought together world leaders on digital fabrication, innovation, and urban design to evaluate future models of operations and research that could be applied to the Fab City project. It was divided into participatory sessions in which participants collaborated on efforts to transform the way we work, live, and play in cities. The objective was to develop a roadmap to secure funding and organisational opportunities for the future of Fab Cities. The summit also resulted in a draft of the Fab City Manifesto, which is to be signed in Paris during the third Fab City Summit.

Barcelona, Amsterdam and Paris share similar Fab City and iCapital stories, since they have been key enablers of these movements in Europe and worldwide, and we hope to continue expanding this international network to make city-making more accessible for everyone.

ASSEMBLING THE FAB CITY LONDON CONSTRUCTION OF A LOCAL ECOSYSTEM

LIZ CORBIN, NAT HUNTER, GARETH OWEN LLOYD & JAMES TOOZE

According to conventional wisdom, fabrication is the process by which raw materials are turned into finished goods on a large scale. The image that pops immediately to mind is that of a brown belt of a regional city, dotted by industrial buildings with puffing smoke-stacks and littered with shipping containers filled with thousands of standardised things for the global market.

Fab City represents an alternative to that dismal vision. It's an aspirational model for cities to reach self-sufficiency, and represents an inversion of traditional notions of fabrication: A Fab City is a place that both makes most of what it consumes and recycles the majority of its waste, in situ. Makerspaces are seen as a prototype for this; rather than ordering in 1,000 stools to be shipped in from a factory abroad, Fab Citizens would download a design file and fabricate their stools out of recycled materials in their local Fab Lab.

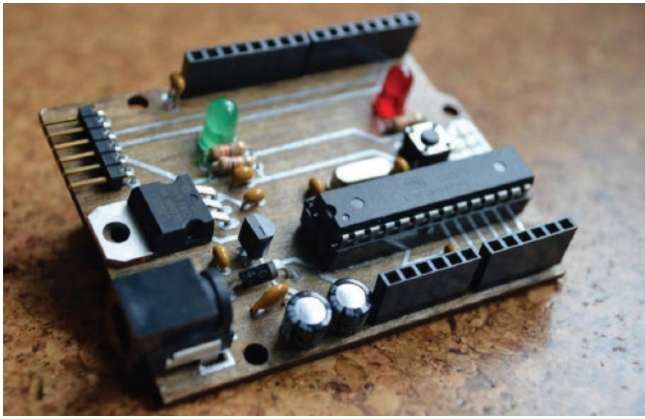
In a corner of East London these two forms of local manufacturing—the traditional light industrial workshops and the new fabrication laboratories—are working side by side. The Maker Mile is a one-mile radius creative cluster of over 50 makerspaces, fabricators, studios and workshops in East London. The area centres around the spot where Mare Street crosses the old industrial transport hub of Regent's Canal, which marks the boundary line between the boroughs of Hackney and London Fields.

Ornate cast iron gasometers, built by the Imperial Gas Light & Coke Company in the late 1800's, dominate the skyline. Their presence is a constant reminder of the area's working past and, in part, thanks to their potential blast zone, the architecture in their immediate shadow long remained an oval of warehouses and commercial buildings—home to printers, workshops and, just over the water, an iron foundry.

The Maker Mile (www.makermile.cc) was mapped by Machines Room, a Fab Lab just down the canal, on Vyner Street—a cobbled cul de sac

filled with wharfs and warehouses, and home to taxi mechanics, sign printers, and London's oldest umbrella maker. Instigated by Clear Village, with support from Human Cities, Maker Mile launched during London Design Festival 2015. A year later, for London Design Festival 2016, Machines Room hosted the "Fix Our City" exhibition, featuring projects from the Maker Mile. This highlighted the area as a rich example of Fab City principles, showcasing local companies such as Sugru, SAM Labs, Technology Will Save Us, and Open Desk, as well as globally connected projects including Precious Plastic, a D.I.Y. recycling centre in the heart of the Maker Mile.

Most recently, for the 2017 London Design Festival, Machines Room, in collaboration with Distributed Everything at the Royal College of Art, hosted "A New Normal," an exhibition that asked the question, "Who is making products for a world beyond mass-production?" The participants, many of whom had been incubated by Machines Room, were chosen because they're making the future happen right now: a future where people are engaged in the design and production of their own goods by participating in online customisation and digital manufacture. These are not proposals for a future of manufacturing. Each exhibit is a real business that invites the visitor to actively participate in the manufacturing process, be it by laser cutting their own jackets or parametrically designing tables for their homes. "A New Normal" guides visitors through this "new normal" way of life, showing what's it's like to interact with these new products and processes as part of everyday experience. It speaks from the user's perspective, drawing people into these new ways of designing and manufacturing, where the word "mass" means "by the masses," not "en-masse." The Maker Mile is a petri dish for research and experimentation and, as such, it attracts academics and researchers from all over the world, including the key partners outlined below.



Distributed Everything, Royal College of Art, London

Distributed Everything is a research group based in the School of Design at London's Royal College of Art. Work conducted by the group explores new horizons of design, production, and modes of consumption that are driven by the development and the spread of digital technologies, as well as the imperative to reimagine and recalibrate industrial society for a sustainable future. The group grew out of the Future Makespaces in Redistributed Manufacturing network, a two-year-long EPSRC-funded research project that explored the roles open workshops could play in the future of sustainable distributed manufacturing. The group has conducted research on behalf of the AHRC and the British Council. Current research focuses on materials information within the public domain, investigating how to transform the availability, quantity, quality and usability of materials information to make it freely available and highly usable to everyone free of cost, or only a marginal price. These efforts are aimed at significantly improving the decision-making of designers and producers, to aid in material selection and custody in the shift towards a non-polluting, sustainable and resource-efficient economy. Connected to Distributed Everything is the Exploring Emergent Futures platform, or EEF, within the Design Products programme at the RCA. The platform shares practical and theoretical roots with transition design, speculative design, material culture and systems thinking. Students are encouraged to explore an area of interest in depth, testing out what is possible and desirable, in an effort to create work that not only speaks about the subject but demonstrates a preferred vision of the near future. Collaborative projects have been run with Formlabs, Opendesk, SPACE10, and the Institute of Making.

Materiom

Materiom is a social enterprise made up of artists, designers and engineers working from within and across the Fab City Global Initiative. Co-lead by Fab City representatives from Chile and London, Materiom's mission is to enable everyone, everywhere, to participate in the next generation of sustainable materials.

Through its online platform, which launched in June, 2018, Materiom has published an open source library of materials made from locally abundant ingredients, including plastics made from algae, starch, and proteins, and composites made from natural fibres, common minerals, and clays. Material recipes are developed, shared, and connected to digital fabrication guides for laser cutting, moulding, and 3D printing. A global community of designers, scientists, engineers, and artists contribute to the recipes, which are licensed as open source to encourage replication, iteration, and sharing.

Alongside the online platform, Materiom develops educational content for use within STEAM aligned curriculum. With the kitchen and classroom as hubs for a new generation of biomaterials, Materiom is working to teach young professionals and local communities how to tackle the global plastic waste crisis by making sustainable materials from natural ingredients.

To expand the impact of their work, Materiom is currently partnering with the Ellen MacArthur Foundation, the Institute of Making, the Universidad de Santiago de Chile, Fab Lab Santiago, and the global Fab Lab network, as well as with locally embedded civic enterprises, academic research groups, makers, and artisans around the globe. For more information, visit www.materiom.org.

Fab City London

Fab City London, or FCL, is the latest development in the Maker Mile story. The UK branch of the Fab City Global Initiative was formally incorporated in April, 2018, by Liz Corbin, Nat Hunter, Gareth Owen Lloyd, and James Tooze, and is a social impact enterprise for developing and embedding decentralised, civic-led modes of production across urban spaces. The agenda promotes exploration of new approaches to design, production, and consumption that transition society toward a circular economy.

The goal is to now take what we have learned from the Maker Mile and apply it to diverse London communities to develop technologies, strategies, and infrastructures that can be leveraged by all at whatever scale of enterprise, generating initiatives that benefit from a mix of geographical locations and expertise.

ONCE UPON A FAB CITY
THE PARIS CASE

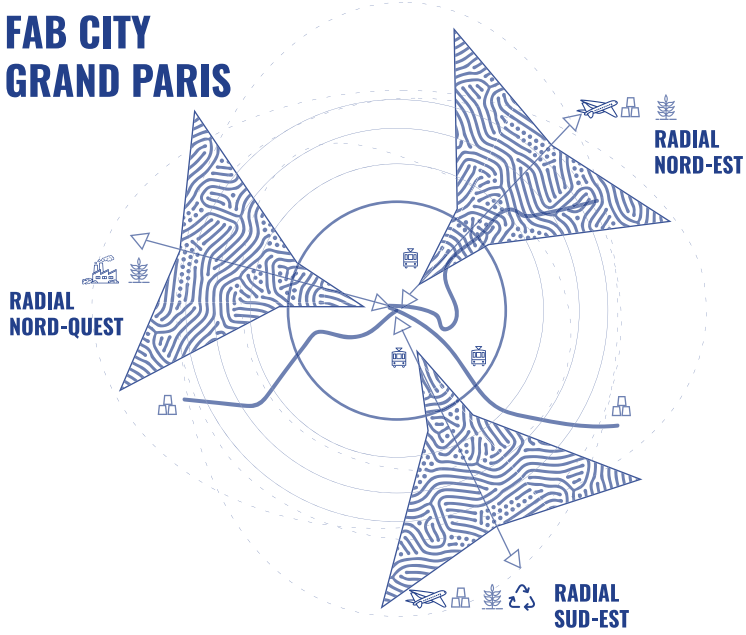
VINCENT GUIMAS, FRANCESCO CINGOLANI & MINH MAN NGUYEN

In the early 2010, the first hackerspaces, Fab Labs, makerspaces, and neighborhood factories began to emerge in Paris and its suburbs. As is their vocation the world over, these open and collaborative factories began to bring together designers, engineers, DIYers, hobbyists, and professionals around common projects and into a common space. The Parisian network exemplified the great vitality and strong affiliation with the open source community. During this period, each place experimented with new ways of conceiving, cooperating, manufacturing, as well as new forms of collective regulation. Very quickly, these experiences intersected around common questions, essential for the future of our societies, while at the same time questioning some of our categories of thought. And very early on, Paris municipal authorities began to take an interest.

In 2013, these incipient players organized an initial form of cooperation, the “SyndiCAD,” around three simple ideas: organizing cooperation between their activities; pooling their ideas; and testing the possibilities of technology as a powerful vector for societal transformation and meeting global challenges.

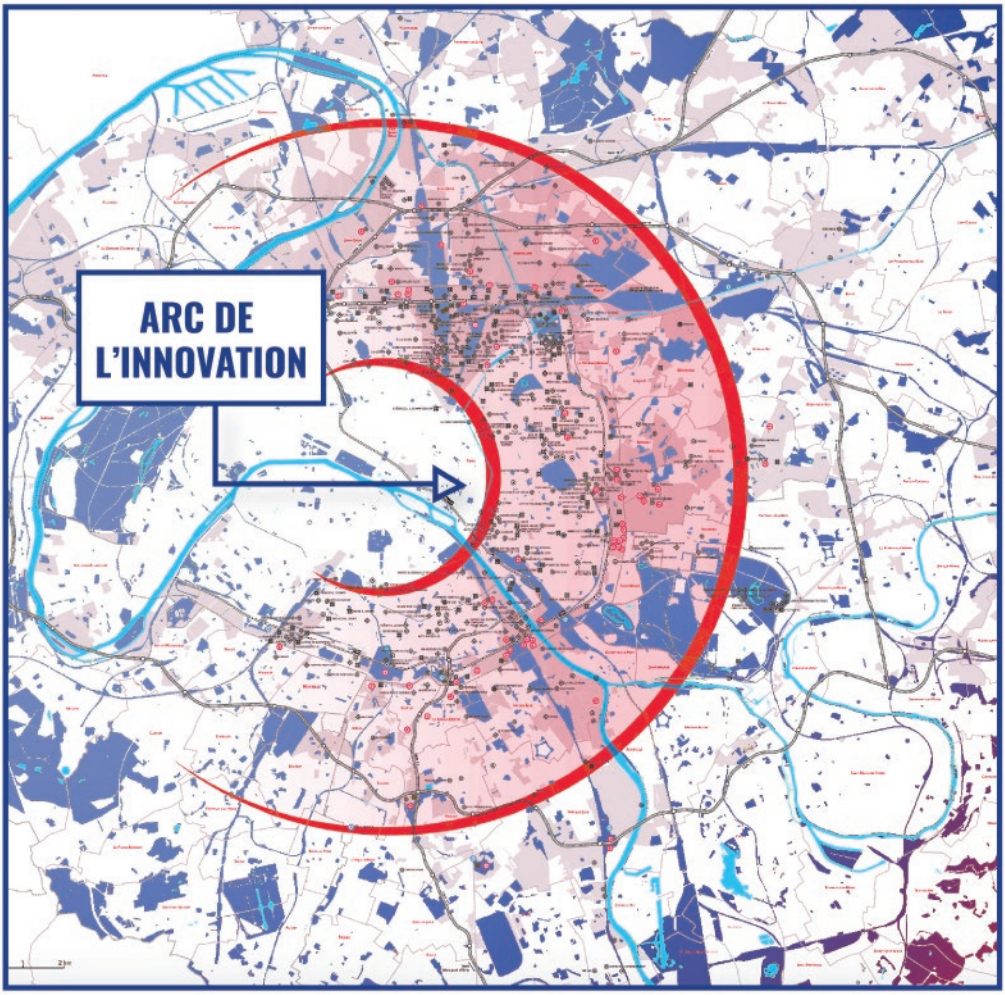
→ See the page **108** to know more about the project in Paris

On July 4, 2016, when the Fab City Grand Paris' barcamp was organized at The Arts Codés, with Tomás Díez in attendance, most participants already had a firm understanding of the challenges and possibilities of Fab City. The Greater Parisian ecosystem was ripe to embark on the worldwide Fab City Global initiative. This workshop gave rise to a map and a project—the Fab City Grand Paris association, which was born on January 21, 2017.



Paris, towards a global maker’s town

In early 2016, the city of Paris developed a “maker” strategy along two main axes—economic development and the circular economy—and on February 24, 2016, its two representatives, Jean-Louis Missika and Antoinette Guhl, unveiled a plan called “Paris, City of Makers.” For Jean-Louis Missika, deputy mayor of Paris, in charge of urban planning, architecture, economic development and the attractiveness of the city of



Map made with the expertise of Fab City Grand Paris.

Paris, "this movement is essential for the Parisian economy of tomorrow because it allows small industrial production to relocate closer to the consumer, breaking with the heavy industry of the 19th and 20th centuries. The city will accompany this movement and accelerate it. We will facilitate its growth, federate, and create a true Parisian community." City authorities also promised a network of 40 new makerspaces in the capital by 2020, meaning that each district would have a ressourcerie or a Fab Lab. In late 2017, the city also developed a training strategy to introduce young Parisians to the world of manufacturing, called Paris Fabrik.

Fast & Precious

In this context, which was conducive to initiatives and quick decisions, Fab City Paris collective asked the city council to join in preparing an application to join the Fab City initiative, as well as a proposal to organize the Fab City Summit in Paris in the summer of 2018. The race was on to prepare the candidacy in time to be presented in early August, 2016, during the FAB12 event in Shenzhen, China. (Work on the proposals even continued through France's sacred summer holiday.) It paid off on both counts, with Paris becoming a Fab City and securing its bid to host the 2018 summit.

Our next challenge came in the form of a proposal by the city to put together a series of recommendations on how to foment Fab City development in Paris. On June 6, 2017, the Fab City Grand Paris association presented the results of its research during a plenary session at Paris City Hall. This meeting presented the different axes of work to be deployed, as well as an ambitious "Prototype Zone" project in the northeast of Paris.

The organization of the Fab City Summit in July, 2018, marked a new beginning between the City of Paris and the Fab City Grand Paris association. And in November, 2017, Paris was named Innovative City 2017 by The European Capital of Innovation. According to the jury, Paris had the most innovative proposal to use digital tools to produce the city. There's no doubt that the Fab City dynamic played a role in the jury's decision, which carried a 1 million euro prize. We turned our attention to the summit: Building a resilient city requires re-activating local production, with more circularity; relying on the power of digital tools; shaking up long-held ideas; moving exemplary projects to scale; and continuing to pursue the idea that transforming the city together is no longer a hypothesis, but a reality that we must chase after.

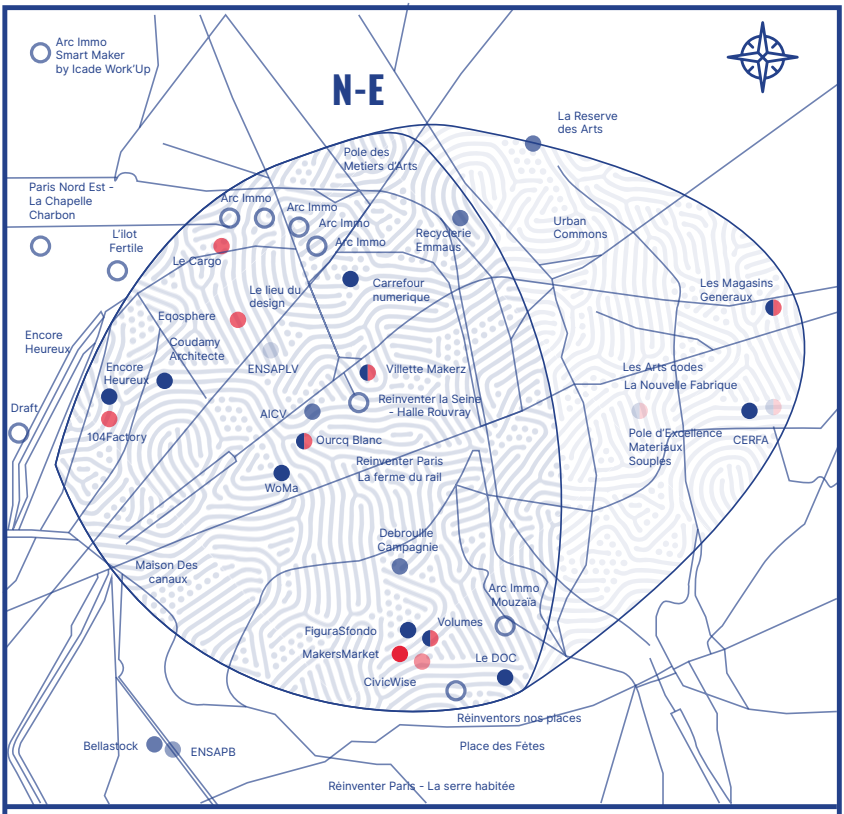
All this frenetic action has also led to introspection. We have been asking ourselves, who should be talking about the cities of tomorrow? More specifically, what is our role? Are we a think tank or an "action tank"? We are concrete utopists. We are not surfing on ideas; we are the "swell machine," invisibly and laboriously making the waves that will launch thousands of ideas, both big and small. And the Fab City Summit in Paris is not only the time of festive communion, it's also a gateway to commitments and actions, now and in the future. It's an open window asking for a "license to do" together, addressed both at the local and international communities.

International Fab City Stream & the Parisian flavors

In Paris, dozens of Fab City projects are already being carried out by a wide variety of players in the Paris region. With the programs “Re-invent Paris,” “Re-invent the Places,” “Re-invent the basements,” many collectives from Fab City Paris began to invent new work strategies. Examples include the collective Quatorze, with the Re-invent Place des Fêtes and Gambetta projects; 6B, with the Place de la Bastille; Sony Lab Sustaintability, with its Fertile City project; and the emergence of experimental urban logistics sites, like Hotel Chapelle International, which had the support of Paris City Hall.

In sum, our adventure is not strictly technical, but rather largely political. It is, we believe, the reason why we’ve been able to scale so quickly. All of our ideas, which come from small and big players alike, have come to the attention of the team at City Hall—the members of which have shown great professional dedication and sometime personal interest as well. None of our realistic utopias were discarded out of hand, and all voices were heard.

Today, Fab City Grand Paris is proposing to raise the stakes, calling on stakeholders to redouble their efforts to take the existing Fab City projects in northeastern Paris to the next level. We feel we’re on the verge of something big.



NORD-EST 19EME - PANTIN

High concentration of actors, especially in innovative and neo-artisanal manufacturing.

Dynamic around the Parc de la Villette with the MakerFaire 2017 and then FAB14 in 2018.

Conducive to experiments in urban logistics: canals of the Ourcq and Saint-Denis, small belt,

Many projects (ARC Immo, Réinventons nos places, Réinventer Paris / La Métropole)

Dynanism of Pantin and land in transformation along the Canal.

The North-East quarter (18e, 19e, 20e, Pantin, Bagnolet, Montreuil), a less expensive land and a rich artistic culture. And the Parc de la Villette, 50 hectares of greenery, 6 cultural institutions, WoMa, Maker make Paris in 2017*

- Site on project
- Innovative Manufacturing - established
- Urban Agriculture Actors
- Reuse and Recycling Site
- Academic Training Place
- Trade and Distribution
- Incubator and Coworking
- Startup and Innovator
- Logistics Center

Proposed prototype area (North East of Paris) to the Paris City Hall, by Fab City Grand Paris, October 2017.

THE CIRCULAR URBAN METABOLISM

CHRIS MONAGHAN & KATE BLACK

In recent decades, the ideal of the circular urban metabolism has gained traction as a framework for operationalizing resource flows within cities and identifying areas for possible improvement. The key to this approach is changing resource flows from linear—under which resources are brought in, used, and then leave as waste—to circular—under which waste becomes another resource, therefore allowing the urban system to become self-contained.

While the concept has been embraced, both theoretically and politically, the practical application of circular metabolisms has largely been limited to the optimization of specific waste or energy flows. Implementing it on the larger neighbourhood or city scale remains a major challenge. But the neighbourhood of Buiksloterham, in the Dutch capital of Amsterdam, is an exception to that rule: As part of the redevelopment of this former industrial area in the northern part of the city, City Hall, a sustainablity consultancy called Metabolic, and a number of other stakeholders, including utilities and social housing corporations have embraced a unified vision for creating a living laboratory for circular urban development.

Buiksloterham as a living lab

→ See the page **104** to know more about the project in Amsterdam

Buiksloterham is a typical post-industrial district, just a three-minute ferry ride from the center of Amsterdam. For most of the 20th century, Buiksloterham was an industrial powerhouse. However, in the second half of the 20th century, several heavy industries left in search for cheaper labor elsewhere, leaving large swaths of centrally located land abandoned. In the 1980s, the municipality of Amsterdam began to rethink the function and zoning of Buiksloterham, developing a spatial vision for the land and investing approximately €39 million, largely in the acquisition of industrial properties. With this, Buiksloterham began its transition from an industrial zone to a combined residential and commercial area.

The planning and development process taking place in Buiksloterham is far from conventional. Whereas normally the municipality would buy out remaining users and clear the land, that approach was financially unviable in Buiksloterham because of its heavily polluted soils, a stagnating construction process, and financing issues stemming from the global economic recession of 2008. To deal with these issues, authorities opted for a gradual and organic approach, under which plots were developed in several phases, or sometimes even one-by-one. The municipality introduced the principle of bottom-up, self-build plots, which allowed individuals or groups to develop and build their own homes. In addition, sustainability tenders were awarded for the right to develop on four separate plots owned by the city. These plots were awarded to different developers who presented the most innovative and sustainable uses for the areas.

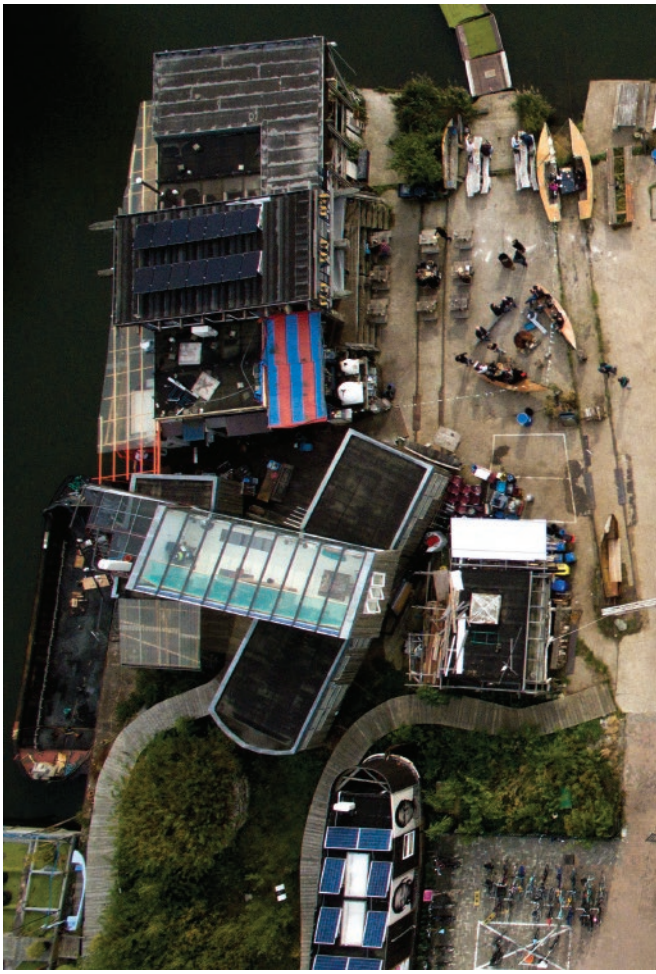
Against the backdrop of these developments, a range of players including utilities, the municipality of Amsterdam, and its social housing corporations signed a manifesto outlining their vision for the area. Their objectives included closing water and nutrient cycles, enacting a smart and sustainable energy plan and forging a climate-proof and resilient neighbourhood. Although the manifesto is non-binding, it set the tone for the new Buiksloterham as a living laboratory for circularity.

The circumstances surrounding the development and planning process of Buiksloterham also contributed to the neighborhood's unique situation, with both the public and private sector participants singlemindedly pursuing the ideal of circular urban development. In contrast to a conventional top-down master plan, the area's development is guided by the circularity principles outlined in the non-formal, non-binding manifesto. Several interesting developments have already taken place, while others others are expected to take off in the near future.

De Ceuvel

Two developments within Buiksloterham share similar, ambitious sustainability targets and serve as an example for future urban development: De Ceuvel, an off-grid office park, and Schoonschip, a sustainable, floating neighbourhood for 46 households, which, although construction has just begun, has already attracted renewed attention to the area.

"Cleantech Playground De Ceuvel" is a partially off-grid, sustainable office park on a former industrial site in Buiksloterham. In 2012, a group of organizations won a tender to turn the site into a "regenerative urban oasis," securing a 10-year lease on the land from the city of Amsterdam. As a leading sustainability consulting and venture-building company, Metabolic, provided the sustainability plan for the site and drew on volunteers and a number of city stakeholders to help make it a reality. Those dedicated volunteers evolved into an active community of creators, makers and doers who felt ownership over the project. The former shipyard now hosts a sustainable restaurant and 16 upcycled houseboats which have been placed on land to serve as offices for some 30 companies, including product designers, architects, and urban planning firms.



Since its inauguration in June, 2014, De Ceuvel has investigated alternative solutions for resource management, focused on household and neighbourhood-scale systems, with low resource consumption and high nutrient recovery. De Ceuvel has become an important showcase and research center for applied sustainability and scalable solutions in Amsterdam. Its experimental nature cultivates diversity, shares expertise, and contributes to open-source

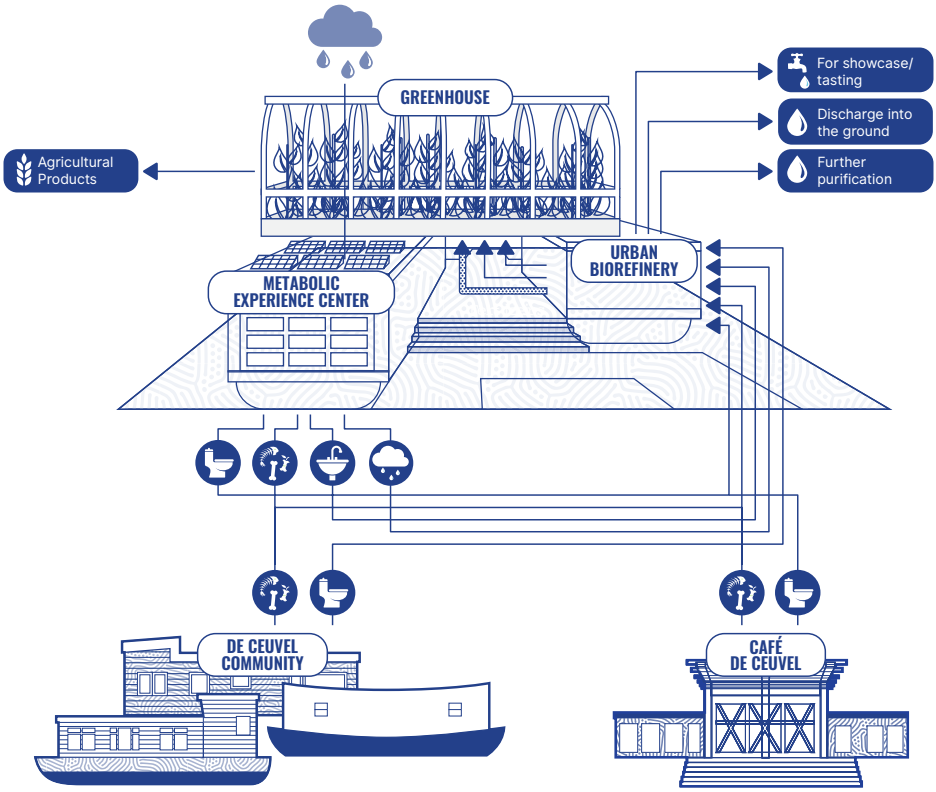
knowledge. It brings alternative methods of urban resource provision to life by setting a positive example and inspiring tens of thousands of visitors every year.

Building

To clean the polluted soil, the land surrounding the buildings was covered with specialized plants that absorb and break down pollutants through their roots, in a process called “phytoremediation.” The offices themselves are made largely out of upcycled materials, with old houseboats hoisted onto the land and renovated into offices, and a café housed in old lifeguarding kiosk, complete with 80-year old nautical bollards.

Community

De Ceuvel's occupants have brought with them a vision for a more sustainable and circular community, and the creative and social enterprises that rent the houseboats-turned-offices are also custodians of the site's sustainable technologies and initiatives. Residents of the surrounding neighborhood have also chipped in and are using De Ceuvel as a community hub. One neighborhood initiative taking place there brings together makers and doers from Amsterdam North to experiment with creative re-use. One product that emerged from this was showcased in De Ceuvel's Het Ware Noorden Light Festival installation, which features upcycled objects, turned into light art. The festival also represented a chance to bring more people into contact with the businesses on site and learn more about sustainability.



Knowledge

Ours is undisputably an era of immense technological advances, and yet these advances don't automatically translate into knowledge. De Ceuvel seeks to fill this vacuum. Metabolic Lab, an on-site learning lab, teaches locals, as well as the wider domestic and international audiences, about applied sustainability, demonstrating how individuals can make an impact in their own communities and organizations. Metabolic provides a variety of educational programs, workshops and masterclasses, ranging from strategies for urban transformation and circular cities to practical skills such as building DIY aquaponics systems. The programs cater to all types of organizations and individuals, with the goal of empowering the maximum number of people to apply circular principles.

Waste

Clever use of technology has helped De Ceuvel's become both professional and "gezellig," which means cosy or friendly in Dutch, while, at the same time, a self-sufficient local system. Little there is wasted, as waste is regarded as a resource. Kitchen wastewater from each office boat is filtered through helophyte filters, made out of sand, gravel, shells and plants, before being released into the ground as a purified water source. All garbage waste is separated and sorted for recycling. And each boat is fitted with a composting toilet. Contrary to conventional flushing toilets which produce wastewater that is discharged into sewers, dry toilets produce solid compost that can be harvested and is prized for its high nutrient value. Urine is collected separately and put through a struvite reactor, which produces the phosphates needed to make fertilizer for local food production.

Food

The café at De Ceuvel serves sustainably and locally sourced food—food so local, in fact, that some of their herbs and vegetables come from right next door, at Metabolic Lab. The aquaponics greenhouse, situated above Metabolic Lab, showcases how clean technology, food production, and nutrient recovery systems can be integrated into urban environments, resulting in more efficient food production and reduced food miles. It combines fish and vegetable production in a closed-loop system, where fish excrement provides nutrients for the plants, and the plants filter the water for the fish. Essential nutrients for food production are also provided by the worms from the on-site composting bin, and also from the struvite reactor, which collects and processes urine from some of the offices.

Café de Ceuvel is in the process of building the world's very first Biogas Boat. In this boat, all organic waste produced at De Ceuvel will be converted into biogas, which can then be used as a fuel for cooking in the restaurant. The remaining organic material can be used as a rich source of nutrients for plants.

Energy

The office boats have been fitted with more than 150 solar panels to meet the structures' heating needs. Heat exchange ventilation systems were also fitted to each boat to efficiently maintain indoor temperatures. Recently, Metabolic's renewable energy venture, Spectral, created a blockchain-based energy sharing token called the Jouliette, which allows companies at De Ceuvel to track their energy usage and exchange energy

locally, depending on whether they're running an energy surplus or deficit. Through this system, points are generated and distributed among the De Ceuvel community, and users are rewarded for efficient use of power and solar panels. In the café, a live map of the site tracks where energy is being generated and traded—allowing the community to take back ownership of their energy production and consumption and reap very tangible rewards.

The community of De Ceuvel has had the opportunity to build and steer many of the initiatives taking place at what has effectively become a living lab for ongoing innovation and continuous improvement. The solutions it has generated are not circular economy "silver bullets," but their visible and tangible nature encourages participation and innovation, and inspires progress. The momentum generated is already leading to other major circular initiatives across the city.

PLATFORMS FOR FAB CITIES: CONNECTING PEOPLE, DATA, PROJECTS, MARKETS WITH CITIES AND REGIONS

MASSIMO MENICHINELLI

A raised level surface on which people or things can stand, or platforms

→ See the page 90 to know more about the project in Barcelona

The growing interest in platforms is arguably one of the consequences of the success of companies like Amazon, Apple, Facebook, and Google, that have based their business models on collaboration with providers and users by building ecosystems, partnerships and communities (Simon, 2011). Their ability to leverage the long tail of markets and communities and scale is one of their most admired features (Anderson, 2008), together with the ability to offer a place for multiple individuals or groups to come together in order to exchange goods and services (Evans and Schmalensee, 2016). We are so used to considering platforms software and hardware entities, at least in the maker and digital world, that we sometimes forget the many meanings of the term platform (Oxford Dictionaries, 2018). Yes, it could be "a standard for the hardware of a computer system, which determines what kinds of software it can run" but, generally speaking, it also means:

1. "A raised level surface on which people or things can stand," generally for mobility and energy infrastructures: the starting point for gathering energy, building and exploring;
2. "The declared policy of a political party or group," the starting point for collective discussions about collective needs, resources, opportunities and initiatives.

Furthermore, there are several other kinds of online or software platforms that are also interesting for different reasons: not for conquering markets and creating profits, but for supporting democratic practices that are environmentally aware, participatory and based on sharing and collaboration. Fabrizio Sestini calls these platforms Collective Awareness Platforms (CAPS), which are not limited to only one sector, but more generally "are defined as ICT systems leveraging the network effect (or the 'collective intelligence') for gathering and making use of open data, by combining social media, distributed knowledge creation, and IoT. They are expected to support environmentally aware, grassroots processes and practices to share knowledge; to achieve changes in lifestyle [...], production and consumption patterns; and to set up more participatory democratic processes. The ultimate goal is to foster a more sustainable future based on a low-carbon, beyond GDP economy, and a resilient, cooperative democratic community." (Sestini, 2012, 58). Rather than just focusing on technology, the goal of such platforms is "to move beyond purely technology-driven solutions to enable new organizational,

social, and governance models. These are needed to face the current societal challenges and achieve sustainability and well-being" (Sestini, 2012, 54). Platforms, therefore, are not only about Facebook and Amazon, but also about building spaces for groups to discuss, negotiate, collaborate, manage conflicts, plan and execute initiatives and connect people and things and places.

Makers, cities and platforms: an ecosystem for Fab Cities

Platforms, be them online or physical infrastructure, or even new future typologies, have an impact on everyone, and also, therefore, over makers, Fab Labs, and Fab Cities. We have been working with and on platforms for a while already: What is the Fab Academy if not a platform? It's a space that allows for discussions and interactions, the construction of the core concepts, skills and networks of the global Fab Lab community, with an online infrastructure and standards. Platforms are most likely more about coordination, support, and collaboration than just the software and the business around them, and in this vein, several interesting platforms for the Fab Lab network and for all the Fab Cities have been developed, researched and deployed, first by Fab Lab Barcelona and now by the Fab City Research Lab (the research and design think-tank launched by Fab Lab Barcelona) at IAAC. These platforms are all cases of software (and even hardware) platforms aimed at supporting and coordinating several aspects of Fab Cities by establishing connections among people, devices, sensors, projects, labs, cities and markets.

One example of such platforms is Smart Citizen[1], an open hardware and software environmental monitoring platform that consists of an Arduino-compatible hardware, a data visualization web, a mobile app and API. This platform enables ordinary citizens to gather information on their environment and make it available to the public online in order to generate participatory processes and to foster citizen engagement through participatory data collection, analysis and action.

Another example is Fab Labs.io[2], the online community of the international Fab Lab community, developed in collaboration with Fab Foundation. The platform hosts the current official list of Fab Labs that share same principles, tools, and philosophy, and connects the people, labs, projects, machines, events, and groups of the global Fab Lab network, with more than 1,200 labs and 14,000 users[3]. Fab Labs.io is a free / open source

1 https://smartcitizen.me/
2 https://www.Fab Labs.io/
3 At the time of writing, May 2018.

software[4] and with open API, it is a software platform that maps labs, connects them with people, and enables them to discuss, create groups, and develop projects.

Connecting labs, people, machines, and projects is also just a first step towards facilitating makers and designers in manufacturing their projects. And right now in the Fab City Research Lab we are working on setting up a new platform, Distributed Design Market (DDM), that will strengthen this aspect of our work by enabling makers and designers to promote, manufacture, and commercialize their projects, while at the same time building stronger supply chains—not just with Fab Labs but also with Hackerspaces, Makerspaces, craftsmen, micro-factories, factories, and so on. This online platform is one of the many activities of the Creative Europe project called Distributed Design Market Platform (DDMP)[5] that aims to promote and improve the connection of makers and designers with Fab Labs.io and the market with the Maker to Market approach, which is also working on the following initiatives:

1. Foster the development and recognition of emerging European Maker and Design culture by supporting makers, their mobility, and the circulation of their work, providing them with international opportunities and highlighting the most outstanding talent;
2. Improve the connections among makers, designers and the market, thus providing tools, strategies, guides, contents, education, events, and networks in order to enable them to commercialize their creations;
3. Stimulate and develop a genuine Europe-wide programming of Maker activities in order to contribute to the development of a vibrant and diverse European Maker and Design culture that can be experienced by a broad range of audience across Europe and beyond;
4. Stimulate the creation of work and of financially sustainable business activities by makers and designers;
5. Develop and manage a label awarding and recognizing Europe-wide makers and designers projects and initiatives in order to recognize and promote excellence at the European scale;
6. Promote the role of Europe in the cultural sector and its connection with the development and coordination of global platforms, networks, and supply chains.

4 https://github.com/Fab Labbcn/Fab Labs.io
5 http://distributeddesign.eu/

An example of a platform developed specifically for Fab Cities is the Fab City Dashboard[6], which is currently a first prototype—more a proof-of-concept than a realistic and complete platform or tool. The idea of this platform emerged in the first version of the Fab City whitepaper (Díez, 2016a, 2016b, 9) with the idea of "establishing metrics to evaluate impact in each participating city." The idea behind the prototype was to design a dashboard that could help cities and citizens understand how citizens design and produce in urban spaces, within networks of suppliers, manufacturers, craftsmen, Fab Labs, Makerspaces, Hackerspaces, and so on. Furthermore, the dashboard also tries to map and visualize the impact these activities have on the resilience and wellbeing of cities.

And more platforms could be added or connected by, for example, connecting with manufacturers, craftsmen, city platforms, data portals, and so on. Interesting platforms in this sphere include Make.Works[7], Materiom[8], Faberin[9], WikiFactory[10], OpenDesk[11]. This group of platforms is becoming an integrated ecosystem of platforms, aimed at supporting and building Fab Cities.

Notes for future development of Fab City platforms

These online platforms started as a test—a project carried out in an educational course or as an experiment—and are now increasingly being developed by larger teams following a more rigorous approach, particularly in European Horizon 2020 and Creative Europe research projects, which bring in not only resources but also expertise from several different organizations and countries. For such experimental platforms, which often begin without a specific market, business model, or funding, it is critical to work within research projects—complicated initiatives which are among the very limited possible options. Here it is important to bear in mind that research and practice are always connected in these projects, where the research aims at understanding and improving the practice. And platforms can also enable a lot of research: for example, Twitter could provide a context for better understanding how the global Fab Lab, Makerspace, and Hackerspace is structured, and how the social dimension of this community could be then strengthened (Menichinelli, 2016).

How could research potentially improve these platforms? I've already written about potential future research for the Fab Lab network as a whole

6 http://dashboard.fab.city/
7 https://make.works/
8 http://materiom.org/
9 https://www.faberin.com/en
10 http://wikifactory.com/
11 https://www.opendesk.cc/

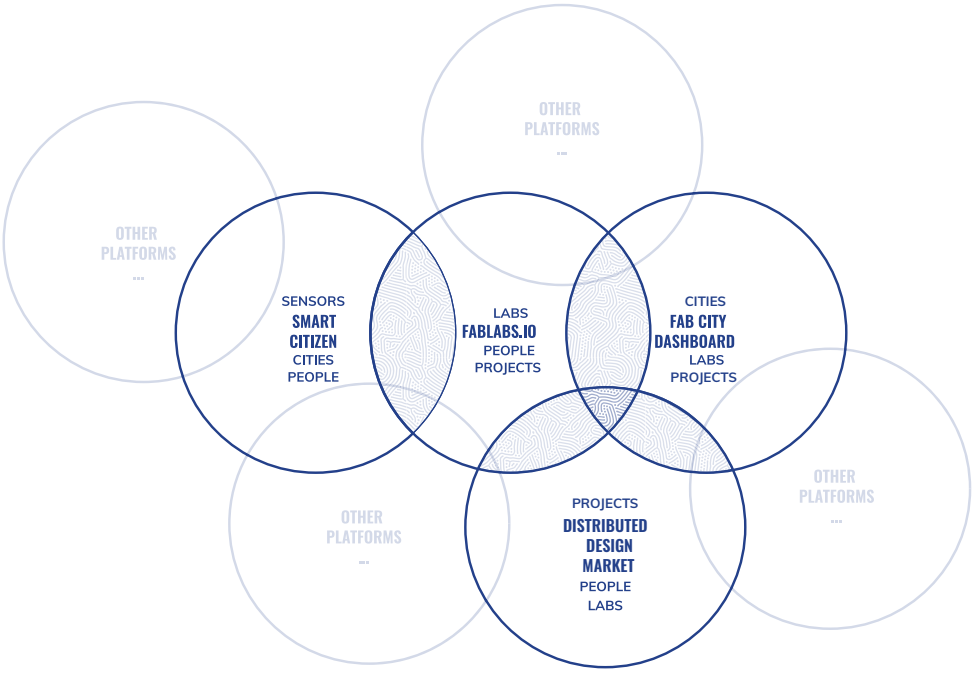


Figure 1: The current status of the platform ecosystem for Fab Cities.

(Menichinelli, 2017b), and my conclusions could be also adopted for Fab Lab and Fab City platforms. Among the several approaches possible for doing research on platforms (which include data analyses, UX research, etc). I would also suggest focusing on the engagement of communities and on the impact of Maker initiatives, from projects to labs. In this vein, the two Horizon 2020 projects Making Sense and MAKE-IT are very interesting for Fab City platforms.

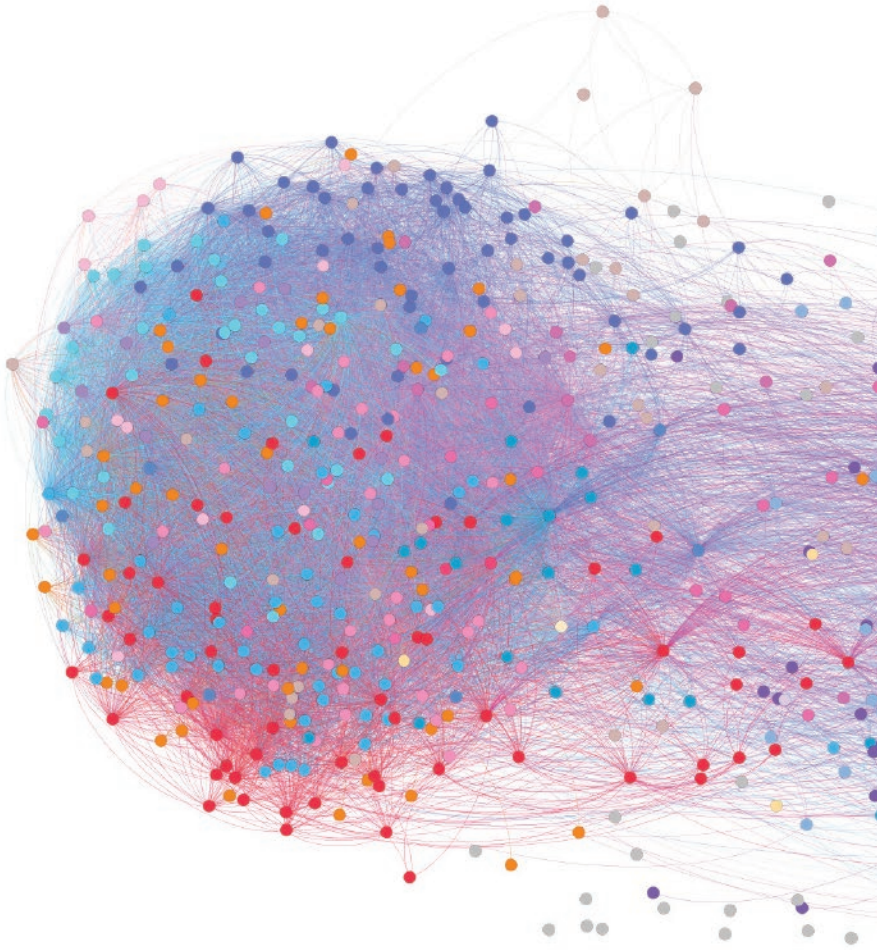
Making Sense[12] focused on the role of CAPS in the fields of citizen science, community activism and participatory sensing, government officials and other public policy actors who wish to include citizens' voices in the decision-making process. This project developed a form of citizen participation in environmental monitoring and bottom-up, participatory and community-empowering action dubbed "citizen sensing" (Woods *et al.*, 2018).

MAKE-IT[13] focused on how the role of CAPS enables the growth and governance of the maker movement, particularly in relation to Information Technology, using and creating social innovations, and achieving sustain-

12 http://making-sense.eu/
13 http://make-it.io/

ability. One of the most important elements of MAKE-IT, especially for future research, is its main analytical framework (Millard, 2016), which can be adopted to help understand the impact and social dimension of maker initiatives—and not just on platforms. The focus of MAKE-IT and its analytical pillars (Figure) is on the role of CAPs in both enabling and understanding how maker communities are organized and governed, on understanding which behaviors this generates, and how all these impact and add value to society.

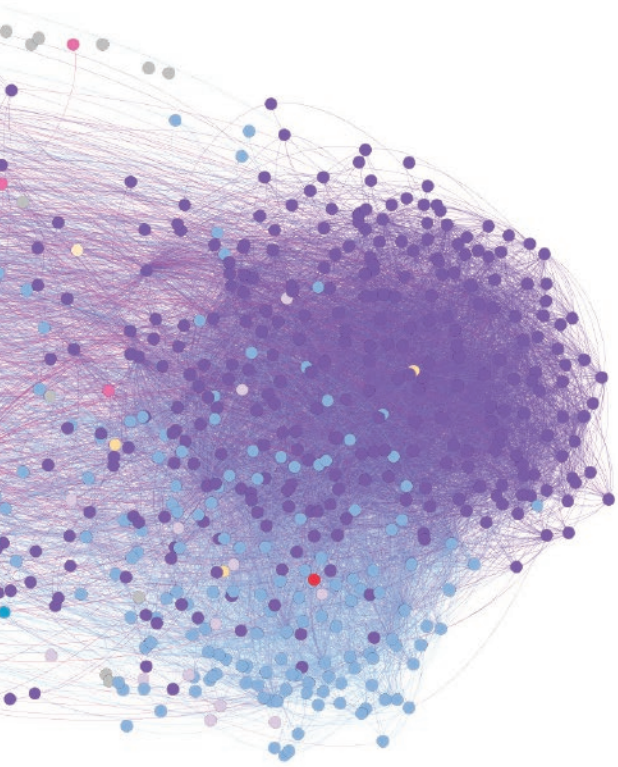
Ultimately, if we understand our impact and the role of our platforms in it, we can improve both the impact and the platforms. This is not a simple task: The MAKE-IT project collected and analyzed all the social



The social structure of the global Fab Lab, Makerspace and Hackerspace communities on Twitter (Menichinelli, 2016).

impact assessment (SIA) frameworks that could be adopted for this, documented their features (Sbeih *et al.*, 2017), and analyzed them in an open dataset (Sbeih *et al.*, 2018). But we still need to move away from a proliferation of frameworks, toward a simpler approach. Embedding them into platforms like Fab Labs.io is a good strategy: What if everyone could measure their impact by using a tool on Fab Labs.io instead of studying and applying theoretical frameworks? This would make it easier for people to understand their impact, and, at the platform level, get an overall view of the impact of local and global communities.

How can we be sure that these Fab Lab and Fab City platforms are really digital social innovations? This is a promising strategy that would enable Fab Cities to understand what they could bring to society and economy. In turn, working on these platforms and research projects is an important opportunity for improving the way labs are organized, developing projects, doing research, interacting with stakeholders, proving their value in a clearer way, and improving the management of initiatives and networks among us. This would, ultimately, help us better define who we are as individual makers and as communities of makers and labs.



FAB VILLAGE CONNECTED RURAL AREAS

DAVID LI

The emergence of the maker movement and rapid growth of Fab Lab have started to generate discussions about the future of how we live, play, and produce things. The Fab City initiative calls for the sustainable development of "locally productive and globally connected cities" to rebalance and redistribute the productions of things. Shenzhen is part of the Fab City initiative but it's also located in the heart of the Pearl River Delta—dubbed the factory of the world. Shenzhen itself now produces 90 % of the world's global electronics. As a wry joke during the Fab City panel at FAB12 in Shenzhen had it, "if all other members of Fab City do it right, Shenzhen will go from overproduction to self-sufficiency."

Because of our unique background, we set out to ask the questions of Fab City in a different setting and examine the goal of "globally connected and locally productive" not from the perspective of an urban area, but that of a rural Chinese village. The goal is to explore how Fab City's ideas can be applied to the country's rural farming villages, which are still dominated by the agricultural economy, and also to examine how Fab Labs can bring transformation and development to rural areas.

Rural villages and poverty alleviation

With all the news about the breakneck pace of development in China, it's all too easy to forget that China is still a developing country, with more than 43 million people living in abject poverty and, some contend, millions more scraping by barely above the official poverty threshold. Lifting those tens of millions of people out of poverty has become President Xi's top priority. Under an ambitious plan to alleviate poverty by 2020, villages have become the focus of new ideas aimed at improving rural lives and lifestyles.

Xingguang Village in Huizhou

→ See the page 102 to know more about the project in Shenzhen

As part of the "Hello Shenzhen" exchange program in 2016, SZOIL/ShanzhaiCity/Future+ hosted resident Jo Ashbridge of Azuko in the Xingguang village in Huizhou, some 90 minutes north of Shenzhen. Xingguang has been designated as one of the target villages for poverty alleviation, and the residence is part of a series of activities exploring what can be done in Xingguang.

One of the key events of the three-week-long residence was a global design competition called "Reimagining the Forgotten Buildings of Xingguang Village," which received 32 submissions from 12 countries. One winning submission was selected, as well as three honorable mentions and a people's choice award. The submissions were showcased around the abandoned buildings that dot the villages, and a small ceremony was held in the town square.

Villagers old and young participated in the event, examining the submissions with curiosity and casting their ballots for the people's choice award. The prize ended up going to a project called the "Beast of Guangdong," which brought together the nearby river and the myth of the Loch Ness Monster to create a new tourist attraction.

Globally connected: fast ideas consumed slowly with community

Many lessons were gleaned from the "Reimagining" project about what "globally connected" means in the lives of rural people. While both the project's participants and the villagers of Xingguang use 4G smart phones and are Internet savvy, the way the submissions were displayed in the village context led to a truly novel experience. The ideas generated by the global network were consumed in a communal manner, amidst a festive atmosphere that ended with the participants being invited to a nearby wedding party to continue the conversations.

The experience contrasted with our typical urban lives, where ideas, Likes, and Retweets are generated as fast as they are discarded on the small, shining screens of our smart phones. Consuming ideas at lightening speed is an integral part of our urban lives. Therefore, stopping to appreciate and savor new ideas generated both great excitement and conversations.

Finding the right village: Yangtou

While the experiences we had in Xingguang were eye-opening, the village was too large for us to actually implement the ideas. We began to search for a more suitable setting to take the project to the next stage. In late 2017, we started, along with our partners, Ningde Satellite Big Data, to examine a string of nine villages in the city of Ningde, Fujian province, where the company was planning to retrofit modern technologies as part of a program aiming to alleviate poverty through modern agriculture. We presented the idea of Fab Village to city officials and were granted permission to bring Fab Village to Yangtou, a 600- year-old village made up largely of elderly farmers whose younger relatives have migrated to cities to work. Very little of China's recent progress has trickled down to Yangtou, which now has just 80 full-time residents.

SDG with technologies

The partnership with Ningde Satellite Big Data brings another layer of global connectivity to the project. The company is planning to launch satellites to collect soil analysis data. Blimps outfitted with spectrometers will be deployed over the village as part of a pilot project testing satellite data's use in precision agriculture.

And because the village, with its aging population, is grappling with labor shortages, we hope to bring in farming robots with AI.

Locally Productive: Learning by Funding

One of the big advantages of a Fab Lab is the access it provides to a repository of open projects and digital production, which allows curious amateurs to delve into innovative and impactful projects.

We're experimenting with educational tourism as a way to recruit curious and passionate amateurs to crowd fund the proposed projects. The model has been tested over/ the past winter and summer in form of camps, and the results were promising.

Small numbers of passionate learners are able to fund globally sourced and locally impactful projects, enabled by the digital fabrication capacity of Fab Lab. In the context of Fab Village, we see this as a kind of local productivity. It's not about local production capacity, but rather about how it enables people to leverage global resources to solve local problems.

Funding projects: Grants and VC don't apply

Given that the ideas are to be sourced globally and that the open technologies are accessible, the last piece of the puzzle is to find a sustainable model for funding the projects. The problem is that while the ideas are ripe for exploration, we know the majority of them will fail to deliver. However, there's no way to be sure which will work out without putting them to the test on the ground.

Traditional funding methods such as grants or venture capital don't really work within this context, because the village—one of the poorest in China—simply isn't attractive to investors or for government grants.

DISTRIBUTED DESIGN
A PERIPHERAL APPROACH

ANDRES BRICEÑO
TOMAS VIVANCO

Since 2012, we've here in Santiago de Chile have been engaging in an introspective debate about what kind of approach to take within our particular context, taking into account our experiences in architecture, design and digital technologies.

We were struck by the gulf between the hype about Chile's stellar economic growth and the reality we were seeing everyday on the ground. We had the impression we were living in a country that's been wholly given over to an extreme neoliberal economic approach, where public institutions acted only in areas not served by the market. In sum, while some Chileans were living almost "Scandinavian" lifestyles, others had developing world standards of living.

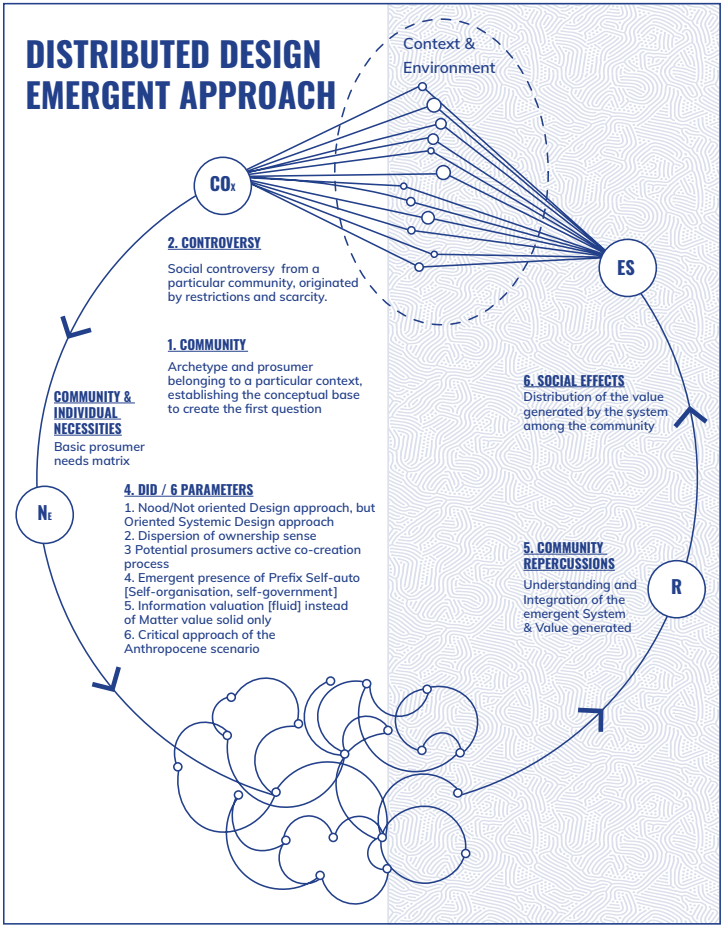
Our main goal, then, was to use a Fab Lab as an instrument of social transformation through design methodologies, proposing from the very start a philosophy related to social conditions. Thus, we aimed to generate a close relationship with our context, understanding, as Alfredo Jaar put it, that "context is everything."

After a couple of years of work within this complicated context, we begin to understand that our design approach was not applicable only to objects, but also to the systems they generate. Therefore, in order to generate systems, we're required to take into account not only the object's design but also its potential influence within its community and context.

→ See the page **112** to know more about the project in Santiago

The agenda we're advocating is basically a systemic approach to design that brings together the possibility of creating an emergent social organisation and expanding the horizon of objects to networks that open citizen participation, potential interaction, and, eventually, a process of social cohesion. Considering the considerable distance between people that has resulted from several decades of de-politicization in Latin America, the idea of an integrated society is still regarded as almost utopic—concentrated among groups that at times operate outside the mainstream.

As Nicola Spaldin put it in a recent paper, "The true breakthroughs that will change the course of history will not come from initiatives to improve existing materials or devices, or to advance technologies that have already been identified. Instead, they will come from off-beat individuals or small



teams of fundamental researchers pushing the boundaries of knowledge in directions for which there is not yet an application." [1]

The more technology evolves, the more conditions for design are changing. Nevertheless, the current economic model has generated environmental conditions that hinder the potentiality of all these phenomena. The conventional economic model is based on the premise of justifying the status quo; that is, as Mandred Max-Neef and Philip B. Smith put it in a recent book, in order "to justify the acquisition of wealth and power, the new discipline of economics arose (formerly chrematistics). According to this, poverty is supposed to be determined by natural law, and through such reasoning—marred by an obvious logical gap—it is assumed that when the powerful accumulate wealth, everyone is better off."[2]

This particular approach highlights the very essence of our conventional model, which emphasizes competition, an operative-efficient environment, and, above all, gradually annihilates human beings' natural empathy; in other words, supressing our political and collective approach in favour of an individual one. That, of course, represents an ideal position from which to control the indissoluble conflict: the relationship between the common man and the powerful. Thus, the best tool for balancing the prevailing structure of society is to push for distribution, autonomy, and sustainability.

The emergence of a new materiality

Designing for distribution requires imagining new futures based on the technical and social ramifications of digital technologies. There are three main principles that turn the concept of Distributed Design from a political statement into a realizable utopia, through design, fabrication and distribution.

Human Capital for Design

Co-creation, communitarian design, and even social innovation depend on the energy of experts who have specific and sometimes advanced knowledge. At the same time, common statements like, "people can design their own solutions" disregard the fact that most people don't have access to, or knowledge of, even the most basic principles of design. Transferring methodologies, processes and critical positions into an extended and integrated perspective will allow people to build the knowledge necessary to read, understand, and design their own local solutions.

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1 Spaldin, Nicola, "Fundamental Materials Research and the Course of Human Civilization", *VSH-Bulletin* Nr.2, August 2017.

2 Max-Neef, Manfred, Smith, Philip B.(2014), *La Economía Desenmascarada: del poder y la codicia a la compasión y el bien común*, Ediciones Biebel, Buenos Aires, Argentina.

Circular economy for production

Conventional manufacturing processes are globally connected through raw materials, which are transformed in a constant flow, and end up as trash. Distributed manufacturing builds connections between physical spaces with complementary equipment, using digital connections to transfer data and common processes to produce physical objects. Local and distributed manufacturing spaces require supplies based on local raw materials, nature-based materials, and industrial waste. Because of this, the local transformation of global data will differ from one place to other, creating heterogeneous variations on the same solution.

Availability for Impact

In both centralized and decentralized networks supported by objects as transferable goods, successful transfers will be those with established and direct distribution channels, that allow producers to reach their final consumers. As emerging production centers rely on digital information as elements of transfer, physical objects are removed from the equation and a crisis emerges in the conventional availability of solutions. When a solution is not available, its potential impact decreases to the point of non-existence. For a solution to exist, it must be available. Local solutions hosted on digital platforms are accessible globally, thus creating a distributed network of solutions.

These basic principles don't define, together or separately, what design is. Nevertheless, they propose a new way of defining design and its materiality. If a non-technical design is produced through non-industrial processes and distributed through new digital channels, the form of the physical objects and artifacts that surround us will surely not be the same as they currently are. A new materiality should thus emerge from these processes, from which distribution will appear through new forms of expression, crystalized in interventions that will not be focused on objects as finite elements.

Distributed Design affects the technical and social realms, establishing emerging educational, economic, and productive models, and generating new hierarchical structures. Distribution requires that the materialization of information be modified and adapted to different conditions, without corrupting the implicit script, which should be able to change and adapt according to the requirements of any specific context. Seen from this perspective, objects begin to dematerialize, thus generating broader relationships with their environments and human interactions. In this way, design is de-privatized- becoming open, public, and democratic through digital technologies.

SHAWEI MAKER COMMONS
HYPERLOCAL MANUFACTURING IN THE WORLD'S FACTORY

JASON HILGEFORT

Introduction

In less than a decade, the public perception of Shenzhen—a not-yet 40-year-old city in the south of China, within the country's first Special Economy Zone—has changed dramatically, blossoming from the stereotype of a mass-production sweatshop city filled with suicidal iPhone factory workers into a global innovation hub. Many researchers and media outlets attribute the astounding transformation to the city's shiny new high tech parks, as well as shifting governmental policies. Shenzhen caught the shift of the global outsourcing of manufacturing, becoming the worldwide hub of electronics production. This allowed it to leapfrog such mega-cities as Beijing, Shanghai, and Guangzhou to become one of the wealthiest cities in China. Building on that foundation, Shenzhen developed a complex economic ecosystem that brings together design studios, engineering services, productions, e-commerce, logistics and financing—thus cementing its status as the "Silicon Valley of Hardware."

The success of Shenzhen and its SEZs went far beyond what any economist, businessperson, or even the Chinese government could

possibly have foreseen. Shenzhen, and in many ways the wider Pearl River Delta region, became known as "the world's factory." This brought an enormous flow of factories, money, and people into the region. As a result of its examination of both Western economic models, as well as emerging models from the East, the government resolved around 2000 to restructure Shenzhen's economy, through policy. Examples such as Detroit, Manchester and the Ruhr Valley provided vivid examples of the dangers of continuing to assume that an industrial base can serve a growing regional economy. Meanwhile, countries such as Japan, Korea, and neighboring Hong Kong were providing case studies for transitional regional urban economic models. However, Shenzhen's notorious speed and the Chinese government's strong hand in its markets lead to a more rapid series of actions.

→ See the page **102** to know more about the project in Shenzhen

Throughout Shenzhen, areas once zoned for industrial use on land given to individual companies who were asked to manage parts of the city were now within the emerging urban core of the city. In a bid to "evolve" the city's market realities, the government shifted zoning in those areas from industrial to commercial, often leaving companies struggling to figure out what to do with the shells of industrial buildings. A good example of this reality is Huaqiangbei Electronic Market, or HQB.

Existing production facilities are integral parts of the Shenzhen urban innovation infrastructure, located in the urban villages around the cities, which then connect to the larger factories on the outskirts of the cities. These shops inside the city provide ready access to prototyping and small-batch production capacity. And by drawing on the connections to the factories beyond the city limits, they can also scale up seamlessly.

Entrepreneurs from the streets

We conducted ethnographic research, interviewing and documenting the stories of several entrepreneurs who bootstrapped their businesses in just such a way. We plan to publish the interview videos and transcripts online at a later stage in our research process. Among the interviewees are Eric Pan of SeeedStudio, Jensen Wang of Makeblock and Robin Wu of MeegoPad. While their stories are obviously very different, they share a common thread. All three moved to Shenzhen in their 20s and started their businesses inside their residential apartments, which were located within an urban village. The proximity to machinery enabled them to quickly prototype and validate new ideas, drawing on readily accessible expertise from the shops. The support for rapid, small-batch production allowed them to seize on business opportunities quickly.

In Shenzhen, 97 % of all companies are privately owned, with most of their entrepreneurs getting their start by bootstrapping their business and leveraging the open production ecosystem. A few such examples are Ren Zhengfei, the founder of Huawei, who got his start in Huaqiangbei, selling network routers; Pony Ma, the founder of Tencent, sold CDs and DVDs; Eric Pan, the founder of SeeedStudio, and Jensen Wang, the founder of Makeblock, produced their first batches in the urban villages near Nantou. The open production system in the urban villages and street markets, such as HQB, are the main source of iconic private enterprises in Shenzhen.

Fab Residence

In December 2016, we answered the call for hosting residencies with the "Hello Shenzhen," a partnership between the British Council, The Shenzhen Foundation for International Exchange and Cooperation and Shenzhen Open Innovation Lab. The topic of the residency was "Fab City Now," and the concept was to test out the open production ecosystem in the Shawei urban village as a prototype for Fab City and study the effect that providing convenient access to collaborative tools for production has on urban areas.

We received Katrine Hesseldahl and Victor Strimfors, who were developing a so-called "scale of readiness," aimed at assessing cities' readiness to become Fab Cities. The pair was also developing a new model for the sustainable distributed manufacturing of products. The sofa was our "vehicle of thought," which allowed us to test our theories on how products can be perceived, designed and even owned. With this project, we aim to design objects with the different life expectancies of their various component parts in mind. The theory is based on Steward Brand's concept of "pace layers." We're interested in exploring how the "recipe," or "protocol," of our designed product works and is interpreted in different manufacturing contexts. Shawei is a unique urban village in a unique city, and it will be interesting to see what a product created super locally, using only materials, skills and machines found within Shawei, will look like. An important component of this residency, besides developing our design through "Shenzhen speed"-prototyping, is the case study of this particular type of production. With this, our project becomes about designing interventions, rather than about a specific object.

At the end of the residence, Katrina and Victor hosted a chair-making workshop, during which the participants designed and built their own chairs in shops located in an area of three city blocks by three city blocks within the Shawei urban village. The map unveiled a wealth of production facilities, material inventories, as well as network of skills and expertise to help novices like the workshop participants to make their very own chairs.

Developing The Shenzhen Model

In a series of video interviews, research workshops, residencies and actions in the Shawei Industrial urban village, we both document the history of these innovative businesses and their spaces and explore future plans to reorganize urban spaces for entrepreneurship in Shenzhen. By linking design culture to productive places, the work seeks to bolster greater economic opportunities for players on all different levels and scales.

Urban Village Research Workshops

We've conducted two urban village research workshops since 2016 to map the capacities and expertise of the village, as well as the social dynamics of the villages. The goal of the research is to understand how urban villages should evolve in order to continue promoting creativity and fostering entrepreneurship. We conducted a research workshop with professionals, graduate students, and high school students to understand how they perceive the urban village and maker space and how the urban villages could evolve to capture the energy of maker spaces without sacrificing any of the villages' unique qualities.

In the second stage the workshop, the participants walked around the Shawei urban villages to map the resources and expertise, as well as interview the shopkeepers. The interviews made clear that many of the shops in Shawei have extensive experience working with designers from Hong Kong, in addition serving the production needs of their local Shenzhen clients. They also found that many of those working in the shops are not aware of the maker movement and were fascinated to learn about maker spaces.

In the third stage of the workshop, the participants were asked to form small teams and brainstorm about how to maintain the urban villages in the city. What kind of changes would make urban villages more attractive to them? One of the team thought it would be good to inject the urban village with a maker space feeling, and so they created a piece of installation art—made from materials sourced in Shawei. The workshops were designed to be qualitative, instead of quantitative, to help both organizers and participants to gain better understand of the issues at stake in urban villages. We plan to conduct further workshops in 2018 to gather more data before we could start the quantitative analysis.

MAKE IN MILAN
DEVELOPING A FAB CITY ECOSYSTEM INTEGRATING DESIGN, SOCIAL INNOVATION, MAKING AND NEW URBAN MANUFACTURING

MASSIMO BIANCHINI & STEFANO MAFFEI

Milan, 2008–18. From the awarding of EXPO 2015 to the launch of ManifatturaMilano. These two big challenges booked a decade of actions and experiments in the political, social, economic, and scientific fields that have changed Milan into a "city-laboratory," capable of helping forge the transition from the Great Recession to the so-called Fourth Industrial Revolution. The brief story below aims to reconstruct the key steps of this tranformation by examining its protagonists and their initiatives as a way of understanding a future scenario that will enable the City of Milan to think, design and act as a Fab City.

Building a community of urban innovators in Milan

Starting with EXPO 2015, Milan reactivated its institutions, enterprises, universities, creative professionals, citizens and associations to forge a more collaborative context, aimed at fostering a vibrant urban community of innovators in a variety of fields, from the social, economic, technological and creative to the cultural realms. In short, the goal was to create a community of converging communities.

They include the community of design innovators: designers and other creative industries professionals and their agencies, schools, and universities, their craftsmen and companies hailing from the "traditional" fashion industry, as well as the design and communication fields. There are also the social innovators: a community of policy-makers, sociologists, economists, researchers, designers, associations, and institutions that develop services or social enterprises in urban settings. And, finally, there is the community of techno innovators: makers, Fab Labs, engineers, researchers, scientists, start-ups, hi-tech and med-tech companies developing ICT technologies, advanced manufacturing technologies, nano, and biotech. Additionally, there are citizens who act as independent user innovators. They actively participate in the co-design and co-production of goods and services, adopting a sharing economy perspective and paying growing attention to the social and environmental sustainability issues of the circular economy. This urban community comes together in a constellation of hybrid, collaborative spaces that are multidisciplinary, social, and experimental. Nowadays, Milan has over one hundred co-working spaces, over ten Fab Labs and makerspaces, incubators and business accelerators, as well as cultural and creative centers.

The city's universities are also becoming a part of this ecosystem through their growing committed to opening up their facilities and resources to the city and its inhabitants. And so, in Milan, this ecosystem is structuring and infra-structuring itself in order to design, prototype and test initiatives, products and services on an urban scale in the agriculture, manufacturing, ICT, energy and healthcare sectors.

Ingredients for upgrading a Makers City into a Fab City

The "policy(for)making" developed by the Municipality of Milan. Throughout the years of EXPO 2105, the Municipality of Milan progressively took on the role of spearheading and connecting local and international projects focused on the sharing economy and social innovation; on stimulating the growth and development of cultural and digital production spaces; and on experimenting sustainable production activities in urban areas. In 2015, the Municipality of Milan created an Official Register of urban co-working spaces, makerspaces, and Fab Labs operating in the city. The Municipality has supported the upgrade of existing spaces and encouraged the creation of new co-working spaces and makerspaces, particularly in suburban areas and neighborhoods where these services do not yet exist. As a member of the Sharing Cities[1] network, Milan aims to become an ever more sharing and circular economy, just as, as part of the H2020 project, the city aims to to reach near-zero emissions, thanks to the implementation of measures and sustainable solutions to reduce the carbon footprint. On the social innovation side, the City of Milan is also a partner of OpenCare[2], another H2020 project that brings together a community of designers, Fab Labs, and citizens dealing with the social dimensions of public healthcare and focusing on the development of open source and user-friendly healthcare devices. In the agricultural sector, Milan took advantage of the opportunity presented by EXPO 2015 to promote the Urban Food Policy Pact. The UFPP[3] is an international protocol through which cities pledge to develop sustainable food systems offering healthy and accessible food to all, protect biodiversity, and fight food waste. Milan elaborated its urban food policy through a participatory process, to be implemented by the end of 2020. In synergy with this initiative, two other EU projects have been developed: OpenAgri works to develop new skills and innovative social enterprises operating in the urban and suburban agricultural sector; while H2020 U-turn explores new solutions for food logistics and transportation within the city setting.

1 sharingcities.eu
2 opencare.cc
3 milanurbanfoodpolicypact.org

The "industrious" evolution of the Milan maker scene

Historically, Milan has long been an industrial city. Starting in the second half of the last century, Milan progressively established itself as an industrious Fashion and Design Capital—thanks to the extraordinary concentration of creative professionals, events, and cultural initiatives, as well as to the link with the industrial districts that constitute the Made in Italy label.

A 2016 study, entitled "The Cities of Makers" and conducted by the Make in Italy Foundation with Censis, dubbed Milan a "Makers' Capital." Milan is Italy's top city in terms of manufacturing consistency, presence of manufacturing start-ups, and number of Fab Labs and makerspaces. The Municipality of Milan officially recognized ten makerspaces. These spaces, like nearly all Italian Fab Labs, began springing up starting in 2013, thanks to the work of institutions, cultural associations, design studios, groups of makers, activists, and private companies. Two Milan Fab Labs, WeMake[4] and OpenDot[5], have emerged on the municipal and national level as organizers of training and cultural initiatives, as actors in the global network of Fab Labs, and, more recently, as participants in European research projects on healthcare[6]. There's also The Fab Lab[7], which has been configured a specific service offer for companies and startups, while other makerspaces such as Yatta!, Multilab, Cohub, Fab Lab Milano and Makers Hub[8] have sprung up in peripheral areas of the city and offer training and other services for young people, students, and professionals.

Universities, Maker Movement and Fourth Industrial Revolution in Milan
Universities are also playing a significant role in Milan's process of transformation. Sociologists at the Università degli Studi di Milano-Bicocca and Università Cattolica di Milano are studying the impact of makers and makerspaces on urban economic and social development, with a focus on new forms of work in the digital economy and on the devel-

4 wemake.cc
5 www.opendotlab.it
6 www.opendotlab.it
7 www.theFab Lab.it
8 www.spazioyatta.it; www.multilab-rozzano.org; www.cohubmilano.it; www.Fab Labmilano.it; www. makershub.it

opment of the sharing economy. LUISS University, which specializes in management and economics, has collaborated with the Municipality of Milan and other players on the creation of a Digital Manufacturing Hub[9], dedicated to vocational projects, managerial training, and support for startups. Politecnico di Milano is developing initiatives on all fronts relating to the development of a Fab City. Over the past five years, Politecnico di Milano has developed an ecosystem of multidisciplinary and experimental research labs where design, architecture, and various engineering fields explore the relationship between design and new production models, (Fab Lab Polifactory)[10]; experiment with new technologies and manufacturing systems (+ Lab, Index Lab, AddmeLab, Polifab)[11]; study the transformation of the city and the forms of living and production (Saper Lab)[12]; and stimulate the birth of new companies (Polihub)[13]. Finally, Politecnico di Milano is setting up an urban innovation district dedicated to research and technology transfer related to Industry 4.0.

Foundations as enablers of the urban makers ecosystem. Other important players who have facilitated, supported and enabled some of the structures and initiatives developed by the Municipality of Milan, Fab Labs, and universities are foundations. In Milan, several foundations including the Fondazione Bassetti, Fondazione Cariplo, Fondazione Politecnico, Fondazione Brodolini, and Fondazione Together To Go[14] have been particularly active. Their efforts helped bring together makers, Fab Labs, and universities in training projects focusing on schools and businesses, in social innovation projects dedicated to the regeneration of suburbs, or to the development of healthcare products and services.

Prototyping a Fab City: ManifatturaMilano project

The experiences underway in Milan are in synch with the Fab City model, leading this emerging community of urban innovators to aim even higher, with the creation of a project platform that integrates policies, actors, and institutions around the theme of new models of manufacturing production in the city.

ManifatturaMilano[15] is a policy program that aims to promote the development of urban manufacturing and new digital craftsmanship, drawing on the manufacturing and artisanal roots of the city, as well as lessons from the experiences of other European cities. It's part of Milan's smart city

9 www.polihub.it
10 polifactory.polimi.it
11 www.piulab.it, www.indexlab.it, www.addmelab.polimi.it, www.polifab.polimi.it
12 www.abc.polimi.it/biblioteca/saperlab
13 www.polihub.it
14 www.fondazionebassetti.org, www.fondazionecariplo.it, www.fondazionepolitecnico.it, www.fondazionebrodolini.it, togethertogo.org
15 www.manifattura.milano.it

strategy, which is based on two pillars: innovation and inclusion. ManifatturaMilano aims to define the vision and the policy projects to stimulate the growth of the new urban manufacturing ecosystem in Milan; help this emerging community take root in the city; and foster the businesses so they create new jobs, regenerate suburbs, and promote social cohesion.

2017 saw the start of a co-design that united many stakeholders behind goal of developing a tailor-made manufacturing strategy based on six pillars: studies and research; communication; laboratories and services; reuse of underused urban spaces; investment support; education; and training. Its first major initiative was the inaugural edition of the ManifatturaMilanoCamp, which in March, 2018, brought together three communities linked to digital manufacturing projects that had been well-connected internally but poorly connected externally. Those communities included the startups behind projects, products and services with high technological content for Industry 4.0; the community of crafts and manufacturing SMEs which, present mainly in the hinterlands, innovate their production processes using traditional know-how and new technologies; and, finally, the vibrant "urban" community of designers, makers, artisans, Fab Labs, co-workers and self-producers. At the camp, these three communities came together for the first time. They met and shared their experiences, as part of a large networking event that included 112 speakers from 88 different organizations.

Together, these elements, players, and initiatives make up the initial embryo of an ecosystem aimed at transforming Milan into a Fab City.

GROSS LOCAL HAPPINESS

FAB COUNTRY BHUTAN

TSEWANG LHUNDUP

Before I embark into the Gross local Happiness, it is essential to share the development philosophy of Bhutan. Bhutan has gone through a tremendous development process over the past five decades. Having started its development process only in the 1960s with limited infra-structure and bare minimum of health and education facilities.

As a Buddhist country, the symbolism of bringing happiness and peace to all sentient beings (including non- human beings) plays a key role in defining how Bhutanese live their lives. It encompasses emotional, spiritual, cultural and economic concerns that constitute individual happiness. Since the beginning of the Five-Year Plans (FYP) in the 1960s this concept has pervaded into the development policy of Bhutan. The goal of development was making 'people prosperous and happy.' In 1971, when Bhutan joined the UN, the prominence of 'prosperity and happiness' was highlighted. Similarly, the King Jigme Singye Wangchuck the great forth, in the early years of his reign, declared that "our country's policy is to consolidate our sovereignty to achieve economic self-reliance, prosperity and happiness for our country and people."

Consequently, in late 1980s, HM the King formally introduced his vision for Bhutan by enunciating the concept of happiness by declaring: "Gross National Happiness is more important than Gross National Product," whereby happiness takes precedence over economic prosperity in the national development. The concept of GNH is human centered, as it places the individual at the center of all development efforts and recognizes that material, spiritual and emotional needs of the individuals must be fulfilled. So the development efforts have been directed towards fulfilling these needs rather than material needs only.

→ See the page 110 to know more about the project in Bhutan

GNH rests on 'four pillars' of development principles: sustainable and equitable economic development, conservation of the environment, preservation and promotion of culture and good governance. The development efforts need meticulous orchestration of these principles, intended to bring harmonious development in the future, balancing environmental sustainability, social well-being and spiritual richness of the Bhutanese society. Today Bhutan has reached a stage where the quality of life of its people is vastly improved. Health coverage is 95 %; literacy rate is 93 %; access to safe drinking water is 94 %; electricity coverage is 98 %. Modern institutions have been built, democracy has been forcefully established top- down by the King, and the foundation for the economy has been broadened.

The modern development history of Bhutan begins with the launching of the First Five Year Plan (FYP) in 1960. The development objectives of Bhutan were never too ambitious. Being a small and relatively poor country, the only way to retain sovereignty was felt to be preserving culture and promoting economic self-reliance. The successive development plans reflect sustainable growth as the key to development, as a result—Bhutan is now graduating from the least develop country (LDC) category. Bhutan has fullfill the graduation criteria since 2015 as per United Nations's Committe for Developing Policy (CDP).

Bhutan is committed to graduation from the LDC category, we have always regarded graduation as significant development milestone and not an end itself. We regard graduation to be a statement to success at three levels.

First a testament to national development efforts under the guidance and wisdom of our monarchs. Second a testament to a successful partnership with the international community to their generosity and cooperation in our national development efforts and third a testament to the hard work and efforts of our Bhutanese peoples. Bhutan is now in the implementation of the last full plan 12th FYD from 2018–23 before the graduation to Middle Income Country. This ambitious plan will address the remaining challenges in sectors of the economic realm to ensure that Bhutan is able to graduate from LDC category in a very sustainable manner. This will be achieved through an economic diversification drive that will translate growth into meaningful jobs and will strengthen the prospect of a brighter future for our Bhutanese people. The 12 FYP is also an opportunity for Bhutan to mainstream transition from LDC graduation as well as incorporate our commitments to achieve the United Nations targets of the 17th Sustainable Development Goals. In the last mile of graduation, the focus will remain on capacity building, technology transfer and knowledge dissemination.

Here the Fab City network and its know-how is an excellent vehicle and platform to leapfrog Bhutan into 21st century technology. Bhutan today is rapidly getting transformed into a knowledge society. A young and aspirational Bhutan and its ease with technology have created this change momentum.

Entrepreneurship, innovative business solutions, and new education and training concepts have today created new paradigms in the society. However, these new paradigms require a different response mechanism from organizations and individuals.

While Bhutan's small size makes it difficult to attract foreign companies, it´s fertile ground for homegrown innovation. Over the last three years we have gone all the way through this Fab City Bhutan development journey laid out by Fab City Bhutan team, the policy advocacy and technical inputs have been accompanied with intensive discussions at all levels from the Prime Minister of Bhutan to farmers and school children's to promote development pathways based on how the new digital technologies enable ordinary Bhutanese citizens to organize their mutual interactions so that they can develop their own social innovations. The establishment of the

flagship Fabrication laboratory of Bhutan (Fab Lab Bhutan) in 2017 is one such important milestones.

Fab Lab Bhutan has more than 6000 users registered and a growth rate of 2 to 4 users daily, the demand for such lab is clearly visible. Key to this development is the combination of professional equipment and low-threshold access. A goal of Fab Lab Bhutan is to provide Fab Lab infrastructure throughout Bhutan under the Fab City Bhutan umbrella. In order to sustain and survive economically, we are under process of developing special offers for school children's in close collaboration with the Ministry of Education, We are designing hands-on workshop packages for unemployed youths in collaboration with the Ministry of Labor and Human resources. We have worked with the Bhutan beekeeping community for days, conducting workshops and learning their way of traditional beekeeping. We have developed beehives prototypes at our Fab Lab and distributed to the communities. We have built a solar power pedestrian light for Thinphu Municipality of Bhutan. This is the beauty of using innovation for social benefit, we are reaching the grass roots of the community directly, giving them access to the most advanced methodologies, redefining the supply chain.

As envisioned by the Prime Minister of Bhutan, one of the most ambitious tasks Fab Lab Bhutan has ever embarked, is on a long-term program to develop 21st century technology and innovation infrastructure for Bhutan. Hon´ble PM has given us 12 months to accomplish this daunting task, which ends on July 2018. Due to consistent hard work of our Fab Lab Bhutan team, the task is almost accomplished. Fab 2.0 consist of all the standard equipments which are available at fab Labs around the world. Once we have completed the development of machine making machine prototypes, we will then replicate one Fab Lab into two, and from two Fab Labs it will be replicated into four and likewise accelerated until we have established Fab Labs throughout 20 municipalities of Bhutan. Our mission to develop the world´s first Fab 2.0 is to obtain equipments at a much lower manufacturing cost, compared to the one resulted from conventional applications. This will enhance our ability to make local digital fabrication tools by using locally available raw material. This kind of initiative is so crucial to reinforce the much needed local innovation, thus laying the foundation infrastructure of Fab City Bhutan. In this spirit, time and space, it is now appropriate to term the new coin Gross Local Happiness (GLH). Gone are the days when only large companies had the skills, resources, financial backing and manufacturing capabilities to turn their product ideas into reality. Today, digital fabrication technologies and a global network of

“fab labs” are enabling innovative people to create prototypes of almost anything. Fab 2.0 is only possible due to the power of global Fab Lab network. Here we are collaborating with Fab Lab Rwanda, Fab Lab Milano, Vigyam Ashram in India and the global Fab City network.

Parallel to Fab 2.0 we are also developing Virtual Reality Lab Simulations (VRL) for STEM education in Bhutan. This will Empower the Next Generation of Bhutanese Scientists to transform Bhutan. Our virtual Reality laboratory simulations programs are aimed at university, college and high school level students, within fields such as Biology, Biochemistry, Genetics, Biotechnology, Chemistry, Physics and many more. In order to assist the VLR, we are also now extending the Fab Lab with Bhutan’s first Biological Fabrication Laboratory (Bio Fab Lab Bhutan). BioFab Lab Bhutan will use the same methods and philosophy of worldwide Fab Labs. It evolves prototypes consisting of and containing living matter and materials. We work with fungi, genes, tissue cultures, bacteria algae, wastewater, plants and trees. It will apply a hands-on rapid prototyping to solve real-world everyday problems or get new insights on basic research questions, facilitating the development of new ideas, products and services. The new disciplines within biotechnology such as synthetic biology, biohacking and citizen science are also mentioned as drivers of the next industrial revolution.

Finally, we are developing curricula of Interdisciplinary Master Courses in Digital Fabrication and Architecture in swift collaboration with three leading universities from Europe: Lund University of Sweden, Roskilde university of Denmark, Tallinn University of Technology in Estonia, and three other universities from Asia, namely Royal University of Bhutan, Kerala University in India and Mindanao State University of Phillinines. The global trend of digitalization is leading to a shift in the construction and fabrication industries: computational tools and automation are enabling new forms of local, on-site, and mass customized digital fabrication. These ambitious developments have the potential to massively impact the architecture and construction industry, enabling greater functionality and sustainability.

The Fab Lab Bhutan is an interdisciplinary entry point for all who have creative and/or technological project ideas. It is embedded within a framework of universities, business incubators, funding agencies, specialized MSMEs, industries to provide the lab users with services when their idea grows beyond the scope of the lab. We have excellent regular exchanges with Bhutan policy makers in order to realize the Maker movement as a chance for the society. Collaboration and learning from each other is another important point in the Fab Lab Bhutan. In addition to the physical meeting place provided for joint working and tinkering, a mobile Fab Lab is under procurement so that we can even reach out to farflung rural villages of Bhutan. This will give an equal opportunity and acces to 21st century technology and we leave no one behind in this journey. For the Fab City Bhutan team, Fab Lab Bhutan is an important playground to study internal processes and value creation as well for exploring new ways of expanding the national Fab City Bhutan initiatives in a sustainable way. Of course we also subscribe to the UN 17 Sustainable Development Goals.

CITIZEN SENSING IN THE MAKING

HOW TECHNOLOGY AND DATA CAN EMPOWER PEOPLE TO TAKE THE FUTURE OF CITIES INTO THEIR OWN HANDS

MARA BALESTRINI & GUI SEIZ

→ See the page **90** to know more about the project in Barcelona

The vision set out in the European Union's 7th Environment Action Programme is that by the year 2050, European society should "live well, within the planet's ecological limits." And yet, in order to meet that goal, we urgently need to address sustainability challenges in ecology, economics, politics and culture. One of these challenges is environmental pollution. Air, water, soil, and sound pollution harm human health as well as the health of the natural environment. Although progress has been made to reduce environmental pollution, it still remains a major concern for European cities. Technological solutions that enable the so-called "smart cities" have grown exponentially, and yet they often focus on city management and infrastructure. The inhabitants of cities, citizens, are often overlooked in the quest for technological advances and novelty.

Recent years have seen the rapid growth of the number of Smart Citizens, fuelled by a perceived sense of inertia in governmental responses to pressing local environmental issues; the lack of granularity and uninviting design of official measuring stations; as well as the recent advent of open-source technologies such as Arduino; the creation of makerspaces like Fab Labs; and the growing popularity of crowd funding platforms. By engaging in citizen sensing campaigns, citizens can harness the potential of low-cost sensing devices—often open source—to collect and make sense of data about their environment, identify pollution hotspots and propose remedial actions or policy changes.

Although promising, the vision of truly bottom-up empowerment through open source participatory systems remains elusive. Over the past six years, our studies of user engagement with citizen sensing devices have revealed a number of technical and social issues that can hinder the appropriation of crowd sensing practices at the grassroots level (e.g. Balestrini *et al.*, 2015). Lack of technical skills among users, difficulties with the usability and robustness of the sensing devices, a perceived lack of social interactions and purpose among community members, and problems with data reliability and meaningfulness have too often led to user disengagement. Other citizen sensing projects have faced similar issues. For example, in SafeCast the ten most active volunteers have contributed almost three-quarters of the total data, while the Air Quality Egg lost traction due to major technical shortcomings and issues around data ownership and reliability.

Making Sense aimed to make participatory sensing meaningful, sustainable and scalable, in hopes of empowering communities to take urban pollution into their own hands, while co-creating the largest-ever open source socio-technical toolkit for citizen-generated data.

The Making Sense project

Making Sense was a project funded by the European Commission, under the so-called Collective Awareness Platforms for Sustainable Social Innovation, or CAPSSI. It ran for two years, in 2016 and 2017, and aimed to study how we can create communities that are self-sustained and engage with citizen science projects, particularly urban environmental sensing and monitoring, to create impact and positive social change.

We focused on the global challenge of environmental pollution—particularly as it relates to the local concerns of urban citizens—looking at how to promote interesting new ways of thinking and making through "bottom-up" networks and open hardware communities. The Making Sense project pioneered a participatory approach that overcomes the many gaps that have hindered sustained and meaningful participation in previous IoT and smart city programmes.

The project was developed alongside five European partners. The Institute of Advanced Architecture of Catalunya in Barcelona, the Waag Society in Amsterdam and the Peer Educators Network in Pristina developed three pilot projects through which the Making Sense methodology for community engagement and citizen science were tested and iterated. These methods were assessed by the University of Dundee and the EU's Joint Research Commission in Brussels and were used to inform the development of a Making Sense toolkit—a set of tools, methods and resources enabling citizens to develop their own citizen science campaigns for urban environmental sensing.

Through these experiences, we ultimately aimed to understand how to infrastructure communities with data literacy, critical thinking, open source hardware and software, open design practices, and digital fabrication skills so that they can develop environmental sensors, measure their environment, make sense of the data and start to address pressing

environmental issues. Following this approach, communities can move from awareness to change through public interventions, data visualisation, the reinvention of public spaces or even new policy proposals.

Pilots: real issues, real communities

In the pilots, groups of citizens co-created and shared actionable environmental open data on issues that are fundamental to our well-being but largely invisible to the eye: What's the quality of the air we breathe? What's the quality of the water we drink or swim in? What's the level of sound that our ears are enduring, day and night?

Initial pilots in Barcelona and Kosovo were instrumental in creating Community Champions—highly driven, passionate and collaborative communities of interest and practice that later helped to develop further pilots—in essence, teaching others how to teach. In Barcelona the neighbourhood association from Plaza del Sol in Gracia rolled out a Making Sense pilot to tackle the oppressive noise pollution generated by public drinking and rowdiness. A co-created approach to sensing was developed, and an open general assembly was called to forge a new future for the square, for citizens, by citizens. This pilot was instrumental to solving the problem: The City Council has now agreed to change the use of the square by turning it into a children's playground.

In Kosovo, the persistent measuring activities and campaigning by local interest groups and mobilised, data-literate youth pushed the government—which had previously obfuscated accurate environmental readings—to take steps towards data transparency by publishing previous environmental measurements on official platforms.

Pilots in Amsterdam have focused on making sense of air quality and gamma radiation. The first pilot was conducted with a community of citizens who live on one of the city's most polluted streets, at the crossing of heavy-traffic highways and a canal. In order to identify possible solutions, the data was analysed in collaboration with government officials. The second pilot involved groups of citizens who live near nuclear power stations, testing a low-cost gamma radiation sensor that uses the built-in camera in mobile devices. The objective is to create an advanced warning system, powered by citizens themselves. A third pilot involved thousands of children in a wide range of sensing activities.

An open toolkit

To ensure that other communities around the world benefit from the co-created shared resources, we produced the Making Sense toolkit: a collection of open source technologies and participatory methods that can empower self-organised groups to address their own environmental issues by developing communities and data commons. The toolkit can be accessed through a book, under a Creative Commons license, and a Github repository.

As an open resource, it aims to infrastructure communities of citizens to take on leading roles in improving their cities. This entails not only making technology such as IoT and sensors more accessible, but also providing strategies for organising citizen sensing campaigns, collecting relevant data and producing insights, as well as pushing for behaviour or policy changes.

The toolkit is based on the existing Smart Citizen platform for bottom-up citizen science, which was developed at Fab Lab Barcelona in 2012. It includes an onboarding application that lowers the barrier of entry to IoT, facilitating the process of sensor setup. It includes documentation on how to build air quality and gamma radiation sensors, and how to adapt an array of 30 sensors to the existing Smart Citizen sensor kit. It also comprises documentation on how to create public sensing infrastructures such as the sensorbox, for measuring noise pollution or air quality in public spaces. Moreover, it provides tools for data visualisation and interaction, such as plugins to use sensor data to produce dashboards or to control actuators. Finally, it presents a robust engagement framework, six case studies, and over 20 methodological tools aimed at supporting co-creation, community orchestration and campaigning processes.

The Making Sense Toolkit contributes to a new set of commons aimed at equipping citizens to become producers of the city; harnessing the potential of technologies and investing their expertise, knowledge, and emotional intelligence to create positive change. The toolkit is open and freely available through making-sense.eu. In a world were data and smart city technologies are increasingly kept in the hands of a few, Making Sense is an effort to reclaim data sovereignty and foster citizen innovation for the common good.

THE MASS DISTRIBUTION OF (ALMOST) EVERYTHING

TOMAS DIEZ

Hundreds of years ago, human agriculture made excess production possible, and this led to the accumulation of goods, the concentration of people in towns, and the end of the role of the hunter-gatherer. A few hundred years later, we came up with a system to organise the exchange of services and products at an abstract level: money. Today's economy is based on the flow of real and fictitious money, which simplifies the value of assets, skills, people, resources, and almost every element of reality. Money has become a means and an end in itself.

If agriculture once transformed dramatically the way in which humans inhabited the planet, now the monoculture of money is threatening life itself. Our economy assumes that we have a limitless planet at our disposal, so that we can focus on one single objective, no matter what: cultivating money—as much as we can. What makes the monoculture of money possible is, on the one hand, the control over the access to information (the Internet is being hijacked, in case you had not noticed) and, on the other hand, the concentration of the means for production: energy, agriculture and the objects/tools which allow humans to survive, and to better interact with their habitat. The management (hijacking) of physical assets and natural resources is organized through other abstractions, such as legal systems, economic laws and models backed by national governments and corporations. If we were to democratise the means of production and make them accessible to all, and if we were to own—and protect—our digital information, we would be challenging the very foundations of the current economic, political and social structures.

A whole new deal

Purpose, meaning and ownership are keywords to keep in mind when talking about the impact that future technologies are going to produce in our lives. The conversation is not really about the technical capacities Virtual Reality, Artificial Intelligence, Augmented Reality, Machine Learning, robotics, quantum computers, automation or synthetic biology, or their profitability. What we must ask ourselves is: for whom and for what purpose are these technologies useful? Who decides what to do with them? And how much do we really want to know about them? These are the questions that will motivate individuals, communities and organisations to collaborate in proposing and building new ways to own and use technology, and to put it at the service of human and ecological values, to coexist in harmony with the living systems of the planet. We need to reinvent the future, and not so much to be able to predict it, but to make it more accessible to meet the main challenges of our times, which are mainly social and environmental. For more than ten years now we have been doing research on the role of technology in society at the Fab Lab network, and developing new programs and projects aimed at developing a new productive and economic model for society.

The first Fab Lab outside MIT was created more than a decade ago by Mel King at Boston's South End Technology Center (SETC), in collaboration with MIT's Center for Bits Atoms, directed by Neil Gershenfeld. Mel's vision was to use the technology that the lab could offer to recover the life of

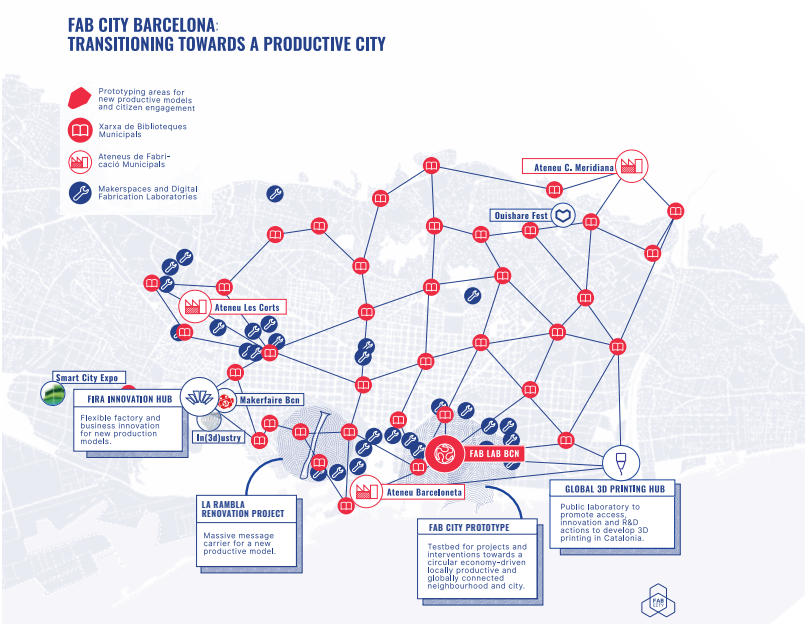
a neighbourhood that had been suffering from racial segregation and economic deprivation for decades, to the benefit of the real estate market. Decades before that first lab in Boston, Jane Jacobs had warned about the negative consequences of mass urban development driven purely by economic principles in New York. She stood up against the interest of the market against the livelihood in cities, represented by Robert Moses, in one of the most famous clashes in the history of city planning, activism and sociology. Jacobs defended the idea that cities should be devised by its citizens, and that the tyranny of the car and the highways, the removal of community identities that had been built by several generations, the market dynamics and progress were killing the cities' DNAs. Kids in Boston's South End were the victims of the new urban model that is still driving city development today. The local community and Mel decided to take action by providing educational programs and opportunities by making technology accessible, to offer a future for neighbourhood's black or Latino kids who were being left behind because they did not fit into the "normal" educational system. SETC has been operating for some 15 years now, offering Boston kids free workshops and advice to develop their creativity. Mel's lab has inspired hundreds of labs around the world, where the social dimension of technology is key. We usually hear that Fab Labs are elitist, or too MIT-centric, or even just a place for nerds, but the world should know more about Mel King, the man who, for the last 50 years, has been organising Sunday brunches at his home, where people sing, discuss and debate community issues, or just get together to read poetry.

Can a Fab Lab help rebuild communities and generate new economic opportunities for everyone?

The first Fab Lab in Europe, located at Barcelona's Poblenou, opened about 11 years ago in a post-industrial neighbourhood with a strong manufacturing and union workers organisation history that used to be known as the Catalan Manchester. The local community in Poblenou has been suffering the consequences of the deindustrialization process that hit almost every city during the last quarter of the 20th century, and the devastating economic crisis that has, among other things, jeopardised the 22@ urban renovation plan (developed by Barcelona's city council to stimulate real estate investment in the area). The 2008 crisis reduced dramatically the options for capital investment in Barcelona, and the real estate market in Poblenou did not boom as expected, even though some university departments did in fact move in, as did a few large corporations that were able to resist the economic meltdown. Then, the neighbourhood began to receive new creative industries—such as design studios, small architecture and design schools, digital production businesses—which, together with art galleries and collectively occupied buildings, began to

create a new neighbourhood identity, similar to Brooklyn's, Wynwood's, or Mitte's, the corresponding gentrification-related issues included.

Poblenou is now becoming an ecosystem where different initiatives are giving it a new, unplanned identity which has emerged as a result of the economic crisis, but also as a result of the obsolescence of traditional planning. The neighbourhood has now a private-initiative association (Poblenou Urban District) which groups most of this creative industries, maintains a communication flow among its members, organises events and promotes the area's potential to the city and beyond. At Poblenou, Fab Lab Barcelona and Fab City found the perfect context in which to settle and build on the future of technology and its potential impact on society.
At Poblenou, the recently launched Maker District (as part of the Barcelona Digital Plan) is now looking to add a new layer to the existing dynamics of the neighbourhood.



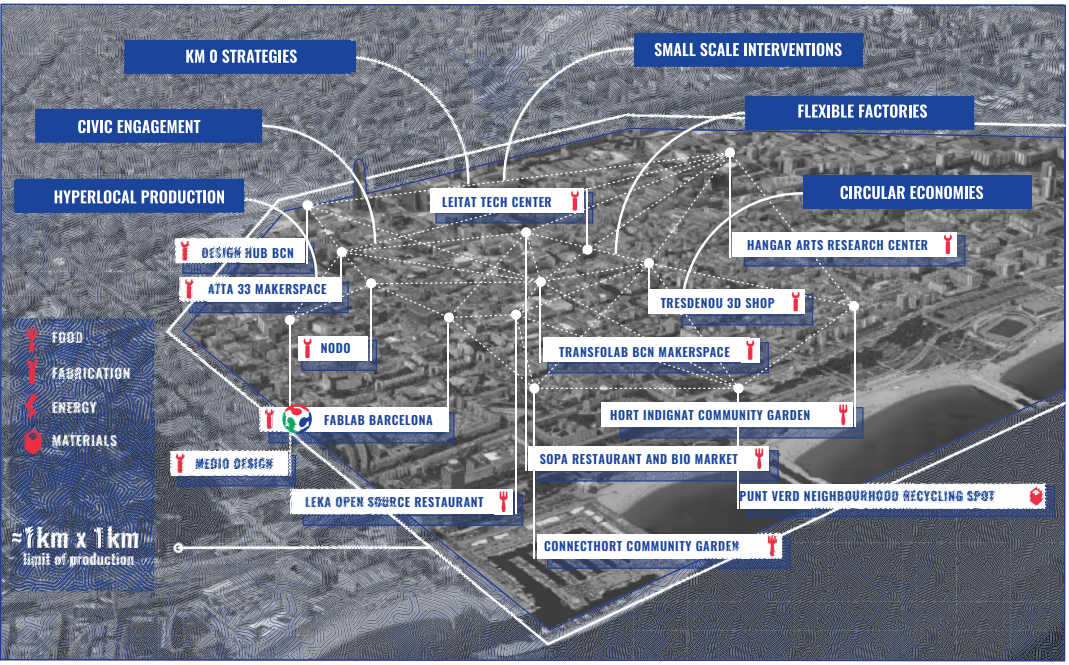
The Maker District has been conceived as a collaborative and co-created process aiming at building, with the local community and a global network, the Fab City project's vision, and creating an experimentation playground to design, make, test and iterate new forms of governance, trade and production at the local (neighbourhood) level, using advanced technologies to accelerate the process of making cities more resilient and inclusive. At the city scale, Fab Lab Barcelona is leading the development of the Fab Labs public network: it advises the city council on building the first infrastructure layer for the Fab City, as described in the project's white paper. The newly named Ateneus de Fabricació are located in

4 different districts by June 2018, and they are still defining their operation principles, mainly between two operation models: a) being bureaucratised by the City Council machine, or b) becoming an avant-garde force for innovation in public policy matters. This is, for now, still an open question.

Beyond public intervention in the Barcelona innovation ecosystem, private initiatives have been flourishing and finding their way to create business opportunities in addition to the maker movement in both Barcelona and Catalonia through spaces such as Makers of Barcelona, TEB (very similar to the SETC model in Boston), Tinkerers Lab, Beach Lab, Green Fab Lab, the BiblioLabs—to name but a few. These spaces make technology accessible to people and businesses in different ways, by connecting it with existing co-working activities, social action initiatives, or educational programs. There is an interesting model to explore, which we have been proposing to different public administrations, that of the public-private partnerships for the creation of new labs: instead of having the city council trying to concentrate innovation and spending millions of Euros in new buildings, less than 30 % of that investment could be directed to private initiatives already happening in the city. These initiatives, in exchange, would offer open school programs and free educational workshops and address unemployment by teaching new skills.

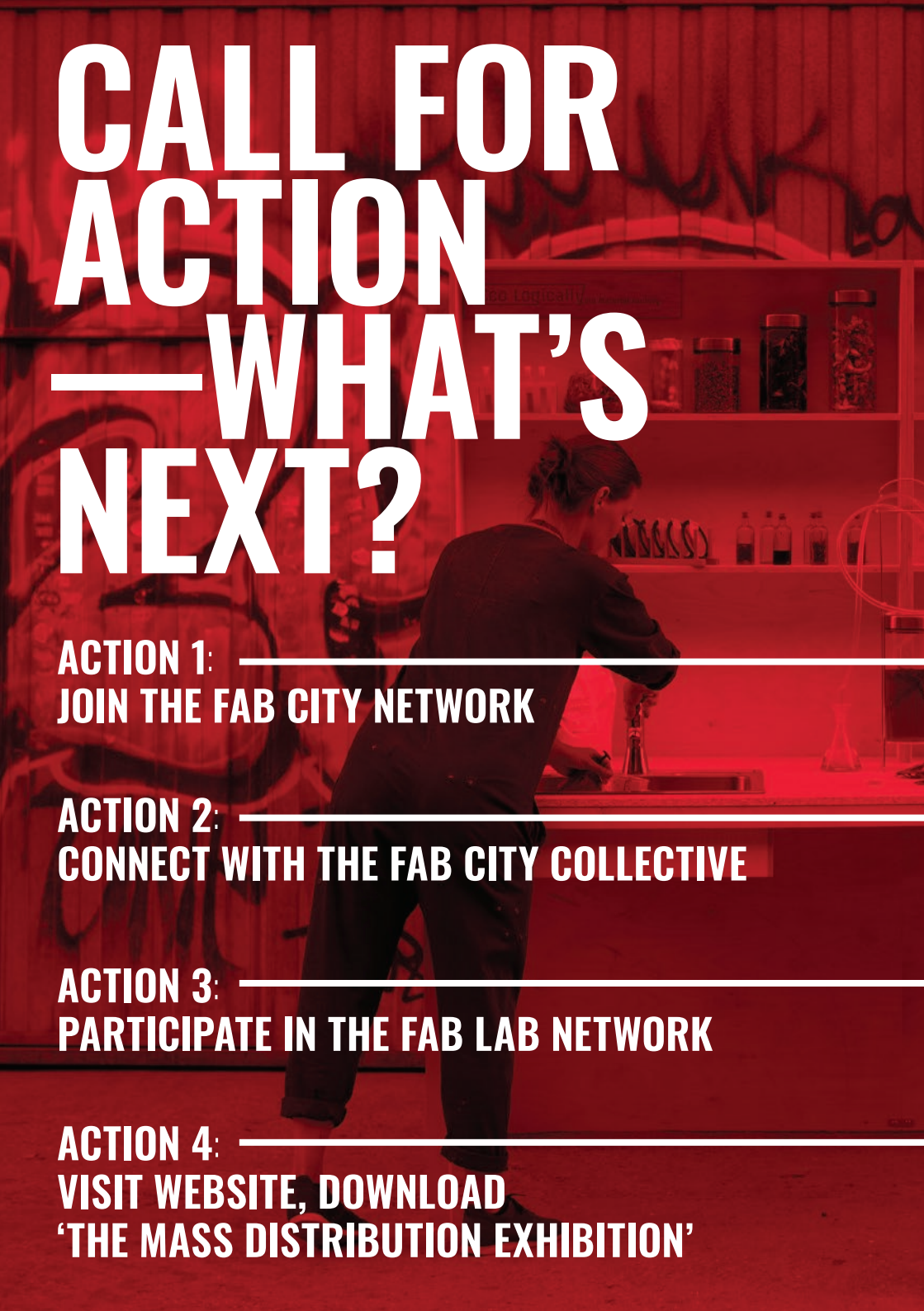
Public and private investment in new digital production technologies in Barcelona is acquiring a larger dimension with the emergence of the 4.0 Industry, which aims to digitise large-scale manufacturing processes. The 4.0 Industry has been wrongly narrowed down to the Internet of Things and 3D printing, which are some of the emergent technologies that will complement manufacturing processes. The new industrialisation of cities must look beyond the techno-centric view and invest in bringing technology closer to people. At the same time, industries should abandon the traditional, extractive economic approach which makes them "takers" instead of "enablers", in order to keep being relevant in a context of distributed production. On the other hand, the public sector might want to experiment with less-controlled models for nurturing new business, employment and innovation forms, without having to spend millions of Euros and Dollars in infrastructure, competing with private initiatives. In this sense, the Catalan government is launching initiatives as a way to create mechanisms to enable the creation of a larger ecosystem in the territory, and understanding the "lab" idea as a permanent way of operating. In our constantly changing world, innovation is not an option: it is a necessity—to keep on improving on the way we do things and having a role to play in the fluid economics context.

Barcelona has a unique ecosystem that can be used as a prototype for new forms of production in cities, something that is also currently happening in Paris, Santiago, Amsterdam, Shenzhen or Detroit, or in



countries like Bhutan and Georgia—all of them places where the Fab City has been adopted and replicated with a local flavour, and is at the same time networked as part of a global community for building a new economic model for the future. With the emergence of new forms of politics in the context of the so-called liquid democracy, we could just be at an interesting turning point for traditional governance in cities which are used to having a strong public presence in almost every sector, only challenged by central governments or large corporations. In a new iteration of democracy, participation should not be merely about giving an opinion or delegating power to elected representatives, but about co-creating and co-building neighbourhoods and cities. The risk here is that, at high-level power struggles (city, region, country, corporations), the other actors (citizens, communities, small businesses) are left to navigate in uncertain waters and ever-changing rules of the game. Without institutional infrastructures enabling new productive city models, we are in danger of repeating the same mistakes the existing extractive, market driven economy has made, now only in the hands of the public sector, or in new forms of private businesses. We have the opportunity to test new forms of governance, with all the actors, in a fair and transparent way, using the technologies as a tool that can make the transition to a new economy possible—the transition to the mass distribution of everything (including democracy, participation, responsibility and governance).

CALL FOR ACTION —WHAT'S NEXT?



ACTION 1:
JOIN THE FAB CITY NETWORK

ACTION 2:
CONNECT WITH THE FAB CITY COLLECTIVE

ACTION 3:
PARTICIPATE IN THE FAB LAB NETWORK

ACTION 4:
VISIT WEBSITE, DOWNLOAD 'THE MASS DISTRIBUTION EXHIBITION'

FAB CITY NETWORK LOCAL CONSORTIA

KERALA

Fab Labkerala.in

Kerala Startup Mission
startupmission.kerala.gov.in

AMSTERDAM

Waag Society / Fab Lab
waag.org

Pakhuis de Zwijger
dezwijger.nl

Metabolic
metabolic.nl

BHUTAN

www.Fab City .bt

Ministry of Education, Ministry of Labour and Human Resources, Royal University of Bhutan, Ministry of Agriculture, Fab Lab Bhutan
Fab Lab.bt

SHENZHEN

Shenzhen Open Innovation Lab
szoil.org

Shenzhen Industrial Design Association
szida.org

SANTIAGO

Fab Labsantiago.org/fab-city-campus-barrio-italia

Fab Lab Santiago
Fab Labsantiago.org

SE Santiago
web.sesantiago.cl

Escuela de Diseño UC
diseno.uc.cl

Distributed Design Foundation
fundaciondid.cl

CURITIBA

Agência Curitiba
agencia.curitiba.pr.gov.br

We Fab
wefab.cc

Curitiba City Hall
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iCities
icities.com.br

SOMERVILLE

fabville.net

FabVille
fabville.net

GEORGIA

Fab Lab.gov.ge

LEPL. Georgia's innovation and technology agency
gita.gov.ge

PARIS

Fab City .paris

Fab City Grand Paris Association
Fab City .paris

City Council of Paris
paris.fr

BREST

Brest Métropole
brest.fr

ADEUPa
adeupa-brest.fr

UBO Open Factory
uboopenfactory.univ-brest.fr

BARCELONA

Fab Lab Barcelona, Institute for Advanced Architecture of Catalonia (IAAC)
Fab Labbcn.org

Barcelona City Council
ajuntament.barcelona.cat

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The rapid urbanisation process of the last century was made possible by the industrial revolution and the assembly line. Today, the fruit of the industrial revolution—standardization and the linear economy—continue to determine how urban dynamics operate: According to the United Nations, today's cities consume most of the world's resources and generate most of world's waste. The exponential growth of digital technologies over the past decade offers the chance to radically remake the cities of tomorrow, based around the global flow of data and the local flow of materials.

Fab City connects globally networks of hyper-local infrastructures for fabrication, production, and distribution of goods and resources. By adopting these strategies, cities can transform production and consumption, replacing standardisation with smart customisation; focusing on interconnected processes instead of isolated products; and crucially, empowering citizens and communities.

The Fab City Global Initiative is an action plan for cities to make this shift.

This book, *Fab City: The Mass Distribution of (almost) everything*, focuses on the power of human-centered technology to transform urban environments and our socioeconomic systems. It showcases the ideas of key thinkers from disciplines including science, design, architecture, urbanism, technology, and sociology, all offering insights from their theoretical and practical experience on how to bring about systems change through the distribution of access to tools and knowledge.

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