

The Fab City Full Stack: A Multiscalar Framework for Distributed Production Strategies in Cities and Regions

Tomas Diez Ladera, Carolina Ferro, Vasilis Niaros, Mitalee Parikh, Ida Jusic

Tomas Diez Ladera, Fab City Foundation

Bali, Indonesia

tomas@fab.city

Carolina Ferro, Fab City Foundation

Medellín, Colombia

carolina@fab.city

Vasilis Niaros, Fab City Foundation

Ioannina, Greece

vasilis@fab.city

Mitalee Parikh, Fab City Foundation

Singapore, Singapore

mitalee@fab.city

Ida Jusic, Fab City Foundation

Barcelona, Spain

ida@fab.city

Abstract

Fab Labs have been democratizing access to digital fabrication and building a global research and innovation network over the last two decades. However, they still face the challenge of creating an impact beyond individual realization through learning new technical skills and small-scale projects. The Fab City Global Initiative complements Fab Labs in this respect and expands the purpose to transforming society. It brings technology available in Fab Labs to cities and rural areas, connecting distributed networks of hyper-local, productive ecosystems. By adopting the Fab City challenge, cities and regions can radically transform how production and consumption occur within their bioregions. The Fab City Global Initiative is a facilitator of an action plan for cities and their bioregions to re-localize the production of energy, food and products, and develop infrastructure to keep atoms moving at the local level and bits traveling globally. This article introduces the Fab City Full Stack, a framework intending to make the mission of Fab City operative. It also describes how the Full Stack assists cities and regions to interpret the Fab City challenge and guides them to implement it in a multiscalar and ecosystemic approach.

Keywords

Urban transformation, bioregions, distributed production, fab labs

1 Introduction

Fab Labs have been democratizing access to digital fabrication and building a global network of research and innovation over the last two decades. However, they still face the challenge of creating an impact beyond individual realization through learning new technical skills and small-scale projects. The Fab City Global Initiative complements Fab Labs in this respect and expands the purpose to transforming society (Diez-Ladera, 2016). It supports the development of new approaches to innovation, learning, and impact at the local level while articulating global efforts. The Fab City Global Initiative brings technology available in Fab Labs to cities and rural areas, connecting distributed networks of hyper-local, productive ecosystems.

By adopting the Fab City challenge, cities and regions can radically transform how production and consumption occur within their bioregions. They can empower individuals and communities while reducing the environmental pressure of industrialization. The Fab City Global Initiative is a facilitator of an action plan for cities and their bioregions to re-localize the production of energy, food and products, and develop infrastructure to keep atoms moving at the local level and bits traveling globally (Gershenfeld, 2012). The Fab City Global Initiative established a 40-year roadmap in Barcelona in 2014 when the city's then-mayor challenged world leaders to develop a new urban model: cities that produce (almost) everything they consume locally while sharing knowledge globally. That challenge has been followed by 40 other cities, regions, and countries such as Detroit, Amsterdam, Shenzhen, Paris, São Paulo, Seoul, Hamburg, and Rennes, among many others.

The Fab City Full Stack intends to make the mission of Fab City operative by enabling the movement of bits of information globally and atoms (materials) locally. It is a framework that helps cities and regions to interpret the Fab City challenge and also guides them to implement it in a multiscalar and ecosystemic approach. The Full Stack assists cities in defining their own Strategic Action Plan that reflects their local community and bioregion.

The rest of the article is structured as follows. Section 2 introduces the Fab City Full Stack and the components of its layers. Next, Section 3 describes how the Fab City Full Stack could be implemented by cities. Last, Section 4 provides some concluding remarks regarding the Full Stack and its importance in the current reality.

2 Unpacking the Fab City Challenge: The Full Stack

In computer science, a series of programs or services work together as a stack to provide specific solutions in software applications (Bratton, 2015). Similarly, a series of articulated actions between actors can provide a framework to address a complex challenge such as the one Fab City faces. From neighborhoods in cities to systemic change, the Fab City Full Stack aims to provide the Fab City Global Initiative with an operation plan that can translate the Product In - Trash Out (PITO) paradigm into a new Data In - Data Out (DIDO) paradigm (Diez-Ladera, 2016). By unfolding in seven specific layers that complement each other, the Full Stack aims to enable efforts between the global network of cities and regions, and create open knowledge repositories to advance a new productive model (Figure 1). This framework is now being used within the Fab City Global Initiative to articulate its distributed innovation and research roadmap.

Adopting a Full Stack strategy can unpack the major challenge of Fab City into smaller parts, which in turn facilitates the development of technologies for urban regeneration. As the challenges ahead are not only technical, political, social or economic but the sum of all operating simultaneously, a framework to articulate such complexity is needed. The scale of the challenge is not nation versus city, centralization versus decentralization, or global versus local. It is the complementarity of scales and strategies that allow the construction of more resilient, inclusive and regenerative sociotechnical systems. This is why, by using the analogy of the Full Stack, Fab City is employing this approach to orchestrate its efforts both locally and globally, as well as use it to identify specific action points to enable the transition towards productive cities.

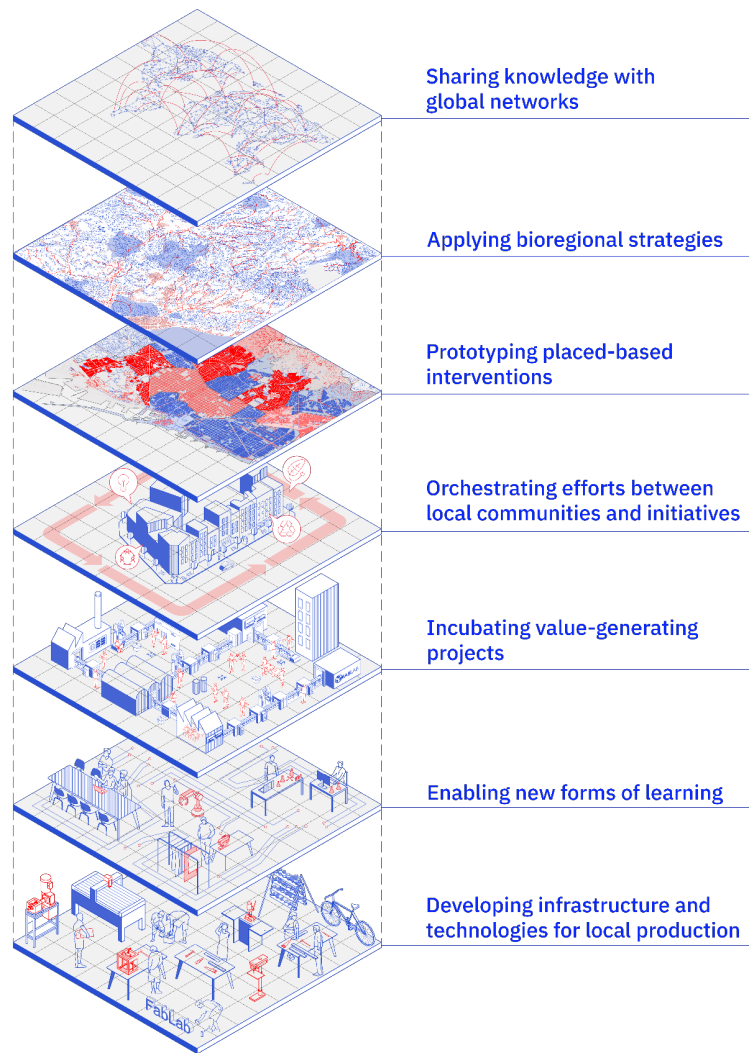


Figure 1. The Fab City Full Stack. Tomas Diez and Zoe Tzika, Fab City Global Initiative.

2.1 Layer 1. Developing Infrastructure and Technologies for Local Production

Layer 1 refers to the necessary infrastructure on the local level, such as innovation spaces (e.g., Fab Labs, makerspaces, hackerspaces, creative hubs, etc.), as well as the core technologies (e.g., digital fabrication tools, new materials, etc.) that can nourish a transition towards a new productive model. The base layer from which the whole Fab City challenge is structured is grounded on the pillars of science and technology but also rooted in the life-supporting systems at the planetary scale. Hence, the fundamental objective for Fab Cities to thrive is based on the application of scientific knowledge in sustaining, regenerating, and nurturing life. The work done by the Center for Bits and Atoms (CBA) at MIT and the global Fab Lab Network in designing future machines, exploring alternative materials, and fabrication processes has been foundational to a new industrial paradigm. In addition, this layer goes beyond the innovation spaces, the machines, and the material aspects and aims at building a sense of community around such spaces with shared values such as openness, inclusivity, and sharing.

2.2 Layer 2. Enabling New Forms of Learning

As the work of CBA is democratized through situated labs and open knowledge, it supports the development of skills and knowledge required to incorporate a new production paradigm in our society, economy, and culture. Currently, the Fab Lab Network brings new approaches to education based on learning-by-doing approaches, as well as project-based learning, as seen in the Academy of Almost

Anything and emergent educational programs of the network. By incorporating digital fabrication tools, principles, machines, and processes in existing formal education, as well as creating new programs, new forms to learn the skills for the future are enabled. This facilitates a transition to educational models that foster the development of creative and critical skills at all levels. Fab City understands that learning to learn is fundamental to continuing evolving knowledge and, therefore, human capacity on a lifelong basis.

2.3 Layer 3. Incubating Value-Generating Projects

Skills acquired in Fab labs are suited to develop hands-on projects in place-based practice. Designs from different distributed networks can be transformed into projects that have an economic, scientific, and social impact at the local scale which can boost the realisation of novel ideas through prototyping and experimentation. A learning environment that incorporates the development of projects as part of the learning process itself allows the emergence of situated solutions to local challenges, which can be applied globally following the PITO-to-DIDO principle of Fab City. This layer also includes frameworks, methods and business models that support the development and utilization of such innovation projects. It focuses on nurturing social and entrepreneurial projects that strengthen the principles of the Fab City Global Initiative and contribute to transforming the existing productive paradigm at multiple scales, from domestic to global contexts.

2.4 Layer 4. Orchestrating Efforts between Local Communities and Initiatives

Fab Labs, makerspaces, and hackerspaces need to engage with their local communities and ecosystems. Layer 4 recognizes this need to strategically develop new local networks based on Fab City values and shared goals. It seeks to articulate existing local efforts and incentivize the active participation of the local communities in innovation projects, which could impact their local context. On this front, Fab City Hubs orchestrate efforts with local communities and act as physical interfaces to connect multiple actors (e.g. neighbors, citizens, makers, organizations, businesses, and public entities). Such hubs also foster collaboration and exchange of skills and knowledge between local communities in a given territory, thus expanding the role and reach of Fab Labs and makerspaces.

2.5 Layer 5. Prototyping Place-Based Interventions

To connect the projects coming out of the Fab Labs and Fab City Hubs closely with their local ecosystem, it's important to prototype the Fab City model on various scales, such as a neighborhood, but also the city itself. The objective is to create local strategies and governance models, and influence policy-making to develop a favorable legal framework for implementing Fab City projects. Fab City prototypes set up an experimentation playground to implement, test, and iterate innovative business opportunities at the local scale in neighborhoods and cities, and create open markets for products and services that support the development of a circular economy. These prototypes are developed by citizens at large and supported by the private and public sectors. The aim is to establish the necessary urban frameworks and lighthouses to guide policymakers to scale the results to metropolitan and bioregional levels.

2.6 Layer 6. Applying Bioregional Strategies

The physical context in which labs, hubs and projects are placed shapes their work. As projects in the form of interventions coming out of these spaces are placed in local communities, they also have impacts on other scales, including the city, or the region they are located in. A bioregional approach to the transition to a new productive model can help improve the relationship humans have with other species. Bioregions are defined by cultural relationships, and by natural systems in each territory (Van Newkirk, 1975). Bioregions allow us to operate on a territorial scale large enough to understand cities beyond their artificial, physical, or political limits. At the same time, bioregions operate within a global logic, such as changes in climate and the interdependence of aquifer systems, transport of microorganisms through the air, or the influence of natural or artificial phenomena on changes in temperature on a local scale (Wahl, 2020). Due to humanity's influence on the ecosystems that make up the bioregions, it is impossible to

neglect this relationship between the biological and the synthetic within the same spatial and cultural dimensions that compose them. Any intervention made in cities, regions, or any other type of settlement, needs to recognize this multi-species approach.

2.7 Layer 7. Sharing Knowledge with Global Networks

Finally, enabling the mechanisms to share knowledge between local and global networks is fundamental, as it is key to understanding the transition from PITO to DIDO. Knowledge exchange is produced in the local contexts, which happens in fab labs, hubs, neighbourhoods, or bioregions. It also contemplates the need to develop metrics to measure progress for cities to produce (almost) everything they consume before 2054.

3 Implementing the Fab City Full Stack

As seen in the previous section, the Fab City Full Stack is a framework that helps cities and regions to interpret the Fab City challenge. However, accomplishing the Fab City goal of cities producing (almost) everything they consume is not an easy task. The Fab City Global Initiative has been unpacking this challenge in many ways over the last years and finally realized that the conceptual framework was the first and fundamental step, but not the last one. Hence, the Fab City Foundation has been developing, in collaboration with members of the Fab City Network, the Fab City Full Stack Implementation Guide, as well as another guide to support localities in developing their own Strategic Action Plan.

Therefore, the implementing the Fab City Full Stack includes three items:

- The conceptual framework;
- The Implementation Guide; and
- A Strategic Action Plan (for each locality).

The Full Stack Implementation Guide (currently under development) supports the Fab City Network members in implementing the Full Stack locally by providing recommendations of objectives, key actions, and knowledge-capturing strategies in each Full Stack layer. The Guide has been devised by the Fab City Foundation team from a four-year engagement coordinating the Fab City Network. It draws on the experience of cities and regions, their ongoing feedback, and the strategic plan of the Foundation to devise clear, yet flexible, guidance. The Implementation Guide has been reviewed through co-creation processes within the Fab City Network.

The Guide is structured around the seven Fab City Full Stack layers. In each layer, Fab cities and regions may find guidance on how to: i. map and research local resources; ii. experiment through community activation, events, and co-creation activities; and iii. rethink local processes and strategies. In addition, each layer presents examples from other Fab Cities, or outside the global initiative, which can inspire and assist cities in refining their efforts at the local level.

The Full Stack Implementation Guide is also structured following the Fab Cities' development level. Currently, the Fab City Global Initiative identifies two main development stages inside the Fab City Network based on the level of involvement of the local Fab City community, as well as the participation of each Fab City within the global community. The first development stage is called "Piloting Fab City" and is about sensing, mapping and envisioning. It is composed of cities and regions that have recently started to define their Fab City journey. These cities and regions are at the stage of connecting with the local community, defining important stakeholders and envisioning the first roadmap to stimulate sustainable development and innovative solutions to environmental and urban challenges. The second development stage is called "Prototyping Fab City". The focus here is on prototyping, evaluating and operationalizing. Cities and regions in this stage show exceptional Fab City developments at the local level and ambitious, collaborative and urgent climate actions with science-backed research. The Fab City Network members in this stage have a clearly defined internal governance structure (e.g., Fab City associations, Fab City cooperatives), as well as established conditions for project generation and potential incubation.

Once their development level is identified, the next step for each city would be to find the relevant information in each of the Full Stack layers to get insights and inspiration to refine their efforts at the local level and develop their own Strategic Action Plan. This plan should consider the local cultural, environmental, and administrative characteristics, as well as the local needs to prioritize its actions. As mentioned, the Full Stack is an operational framework for Fab Cities to implement local strategies at different scales, depending on their core capabilities, interests, and opportunities. It should be highlighted that cities can start applying their Fab City Strategic Action Plan from any of the layers, without a specific order. The Full Stack is composed of a series of non-linear and non-hierarchical interconnected and interdependent layers, that serve as aggregators and organizers of efforts being carried by cities in their ambition to produce (almost) everything they consume.

4 Instead of Conclusions

In the current context of the transformation of the climate and the territory by human activity, it is imperative to articulate efforts to create a better relationship between technology, communities, and bioregions. The challenge is not only to achieve the sustainability of the material world in which we operate today but to use regenerative principles to recover much of the biodiversity sacrificed for the sake of economic and industrial development over the last two centuries. In this sense, it is essential to reconfigure our relationship with living systems that allow us to satisfy the energy needs of the human species, such as electricity or food that serve cities and rural populations.

To achieve a challenge of these dimensions, we must be able to generate opportunities for learning and re-learning, as well as to generate cultural exchange that combines political, cultural and biological dimensions. The Fab City Full Stack can facilitate the applications of existing methodologies, tools, and skills in both local and global environments, and the networking with and within bioregions, cities, communities and individuals that share the purpose of transforming and evolving the way our current urban life works. Only by articulating efforts through collaborative networks on a global scale will it be possible to deal with the difficult task of solving highly complex problems.

It is not an easy task to replace a centuries-old colonialist logic based on artificial scarcity, competition, extraction and exploitation, with new principles based on regeneration and justice, and learning from experimentation in cities, bioregions and human settlements. In the same way that the negative impacts of the daily actions of current urban life generate problems on a global scale, it is possible to think that the articulation of small efforts based on collaboration, open source, and experimentation can lead us to the development of new answers to the questions that we will continue to ask ourselves about the city. Of course, one of the challenges that Fab Labs and Fab Cities face is to create a support program to incentivize and help develop projects from their global networks and become part of global repositories of solutions to some of the critical issues many communities face locally.

As we write, one of the most disruptive pandemics of all time has changed entire economies, a possible third world war is showing on the horizon, climate change is becoming more evident, and it seems we are still struggling to rebuild the world as it was. We might not want to return to the previous “normal”, because that normally does not make sense anymore. It made sense for a very small percentage of the world’s population but not for any natural system or the planet itself. The previous normal has been too focused on searching for growth of the Gross Domestic Product, competition, extractive dynamics, and the exploitation of people and resources. We, as the privileged ones, have the responsibility to enable inclusive and desirable futures for as many people and species on the planet through collaboration, open knowledge, and ecological principles. We do not have time to fight the past, we must put our energy into enabling emergent scenarios that could allow us to test alternatives to organize our world.

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