

Research framework and methodology

Despite their familiarity, infrastructures might be an unusual subject for design. Indeed designers are used to work within them, providing solutions at the front end or improving functionalities and interactions at some points in their networks. However, for the purpose of their work, they do not usually need to be aware of whole system operations and disposition. Except when they are designing new systems and services from scratch, they are rarely asked to question the structures and functionalities of an organization. Nevertheless, to explore how to possibly transform industrial infrastructures towards more contextually adaptive configurations, we somehow need to find ways to relate to these networks beyond the access points we currently interact with. At the same time we need to learn how to work across multiple networks and communities of practice, shifting between different scales and locations.

Observations that open up a set of methodological questions regarding what type of knowledge, materials and design processes might be necessary to enable and curate change within these systems. In particular, the first problem we might need to address is the one of ‘accessibility’. To open up infrastructures for re-interpretation and design we first need to find ways to make their back-end functionalities present and available for such interventions. But how do we deal with the fact that this information is usually privately held, deliberately concealed for competition and security reason and not open for these purposes?

Companies in control of infrastructures are generally interested in expanding their businesses and networks incrementally and in a commoditizing fashion. Everything that does not fit with their specific rationality and way of thinking is usually excluded. To maintain their business however companies needs to evolve. Something ‘unknown’ outside their system is usually evaluated, analyzed and framed according to their own consolidated knowledge and practices (cf. Heidegger 1977; Borgmann 1987). If functional to their purposes, new knowledge and bottom-up innovations can be eventually annexed and formalized within the existing system.

This approach allows for economic robustness, system efficiency and optimization. However, it also represents the main conservative force to the companies’ ability to innovate themselves and a limit to their capacity address local and

systemic issues. Executive managements teams are well aware of these limitations. For instance the social, environmental and economic costs produced by last mile and digital divide problems are typical examples of the effects of this prevalent network-centered planning and design ways of working. Similarly the proliferation of standards and services in certain locations, which in most cases lead to delays and economic, material and energy resources being wasted, is a systemic result of these company-centered perspectives in systems development.

To learn how to possibly overcome these issues alternative ways of planning, design and prototyping infrastructures beyond prevalent single network or community perspectives need to be articulated. This could be experimented within the frame of a redirective practice aimed at questioning current infrastructural configurations and at the exploration of alternatives options and models of value creation, rather than delivering incremental solutions reinforcing the status quo. Nevertheless, this way of working is particularly unfamiliar to companies since it mines their consolidated practices and habits of mind.

This diversity of interpretation about what design is and what it does contributes to the problem of accessibility of infrastructures as material to design with. As long as the designer's work and intentions are aligned with the interests of their sponsors, some information about internal operations might be available. But if the purpose of design is to critically explore and question how to possibly change these systems toward more democratic configurations, opening up them for judgment, suddenly the possibilities to directly access information from the source are very limited. The design work starts to be perceived as 'destabilizing'—challenging established habits, work practices and power relations rather than consolidate them—with no clear economical return, and outside the logic of short term provision of functionalities companies are used to. These issues make access to information difficult to obtain and to argue for without materials or examples of possible outcomes, and are not just a matter of entrepreneurial ability to understand research and innovation.

The lack of transparency regarding the disposition and operations of networks and infrastructures also has political implications. Despite being (in many cases) privatized and therefore following market logic rather than the achievement of a 'public good', the operations and dispositions of infrastructures and services still represent a matter of public concern (Easterling 2014). Private infrastructures maintain a public function affecting, through their presence or absence, the

relations between global geographies and local economies, limiting or fostering citizens' life but not necessarily in preferable ways.

The possibility to access private networks for the purpose of public scrutiny should be, in theory, a prerogative of public life and democratic societies (Dewey 1954). Nevertheless, without a full intelligibility of these systems and all the possible consequences associated with their agency and performance this is not very likely to happen. Thus, certain interventions to produce the necessary material to design and engage publics in an exploration of their configurations and conceive alternative ones might be necessary and, at the same time, ethically justifiable. How to achieve this purpose though, breaking up the constant separation between inside and outside networks, local and global, top-down and bottom-up relationships without causing unnecessary damage and unpredicted rebound effects remains an open question.

Considering the critical nature of this intent and the sensitivity of infrastructures as a field of design inquiry requires designers to first explore and experiment with ways in which such practice could safely unfold. There are several legal and ethical implications concerning the security, privacy and reliability of these systems, the people they serve and employ, of which designers need to be aware of and for which they need to take responsibility of their actions. For this purpose this chapter will attempt to draft a possible framework for a constructive research approach to explore what a possible re-directional design program for the transition of industrial infrastructures might be (cf. Binder and Redström 2006; Redström 2011).

The scope of this framework is to first outline which activities might be necessary to include in this process. This will be later used as a base for a series of design exploration and evaluations of this approach and the possible materials it can make use of. The reason behind this need to experiment is simple yet important: essentially this is a kind of design current practices are not really equipped for. Different methods and approaches need to be first explored and prototyped before being able to clearly articulate what such a practice is, what it does and what it can deliver.

One way to inform how to build a new practice dealing with infrastructural transition and to identify where and how answers will be searched is by looking at theory. Considering its usefulness in articulating the relationships and dynamics through which socio-technical systems are configured and its perspectives—that

in many ways challenge and resists current industrial simplifications and dichotomies— Actor Network Theory will be here introduced as a possible conceptual scaffold to identify possible approaches to navigate the infrastructural space across its networks, people and practices they support. In particular, the concept of figuration will be here presented and expanded as a possible design tactic to understand and reveal the practices and logics of existing infrastructural networks and their designs.

A second extensive body of work to draw from in order to identify what this new practice might be is instead of the set of existing design and research practices that relate to infrastructures. As Cross (2001) argues “What designers especially know about is the “artificial world”—the human-made world of artifacts. What they especially know how to do is the proposing of additions to and changes to the artificial world. Their knowledge, skills, and values lie in the techniques of the artificial. (Not “the sciences of the artificial.”) So design knowledge is of and about the artificial world and how to contribute to the creation and maintenance of that world “ (Cross 2001, 54).

Since infrastructure represents an integral part of the artificial world, design practice might have already developed appropriate forms of knowledge, inherent to the activity of designing, regarding how to engage with their design. Thus, by looking at design ‘as a discipline’ we might identify practices and competences useful to relate to industrial infrastructures, their scale and multiplicity of actors. Drawing from these ‘proto-practices’ can provide us with a starting point to define what tactics and materials a redirective and transitional practice might need to include. These approaches might not be fully equipped for this purposes yet. However, it is by looking at their methods and tools that we might identify a possible way into the infrastructural space to explore possibilities for its reconfiguration.

Figuration

In his book “Reassembling the Social” (2005) Bruno Latour offers a series of concepts and strands of theory helpful to articulate a possible approach to different types of infrastructures in the digital, physical and social and their organizational architectures. Building upon the socio-technical construction, relational and co-evolutionary perspectives, Actor Network Theory suggests the impossibility of setting static universal definitions and analytical descriptions of

society distinct from its technical systems. As an alternative it offers an image of contingent continuously evolving networks and surfaces, whose form and meaning are strictly dependent on the situated agency and interactions between people and things that constitute them. As Latour argues, within a network there is no distinction between local and global, but they are part of the same thing (Latour 2005, 189). He explains this union according to how “the notion of network allows us to dissolve the micro-macro distinction that has plagued social theory from its inception. The whole metaphor of scales going from the individual, to the nation state, through family, extended kin, groups, institutions, etc., is replaced by a metaphor of connections. A network is never bigger than another one, it is simply longer or more intensely connected” (Latour, 1996, 5).

According to Latour (1996) the development of infrastructures can be described through the linkage of large heterogeneous arrays of technical elements and human actors configured across multiples spaces and times. A network implies no *a priori* relations. It is not tied to axiological relations between of top-down and bottom-up offering a way to navigate and trace back element across its hierarchies, its layers and scales:

A network notion is ideally suited to follow the change of scales since it does not require the analyst to partition her world with any a priori scale. The scale, that is, the type, number and topography of connections is left to the actors themselves (. . .) Instead of having to choose between the local and the global view, the notion of network allows us to think of a global entity — a highly connected one — which remains nevertheless continuously local. Instead of opposing the individual level to the mass, or the agency to the structure, we simply follow how a given element becomes strategic through the number of connections it commands and how does it lose its importance when losing its connections. (5-6)

Due to their diversity, these networks of human and non-human agents cannot be generalized but need to be understood through the different local interactions, agencies and relations between their components. Similarly, despite their universality and standardized designs, ‘technological’ networks and infrastructures are always specific and contextualized. They support and affect with their agency different practices and communities, and acquire different meanings from place to place, constantly linking the local and the non-local in relational and reciprocal connection. Through this linking process, time differences and geographical distances are re-configured, producing new realities inside and outside these

networks; Processes that generate exclusions and discriminations in access to networks and infrastructures caused by the different economic power relations that dominate infrastructural implementation for which particular geographical areas and users are privileged compared to others (Graham and Marvin 2001, 8-22).

With technology and technical systems extending to every setting of human life the questioning of the mediations and influences of these networks become both an instrument for social analysis and necessary starting point for any propositional intervention. Because of their political and ethical implications, Latour argues (2005, 88), they are no more exclusive subjects of technical and scientific inquiry, but ‘matter of concerns’ which require us to unbundle and expose the complex set of relations and agencies among different actors, their motivations and interpretations, to be properly addressed. Once revealed, these socio-material constructions become questionable, making it possible to judge the qualities and appropriateness of their designs and configurations. In order to make this possible, Latour offers some methodological suggestion on how to trace these relations.

Relationships within networks and their human and non-human actors are continuously different and evolving (Latour 2005, 43-86). Neither a concept of society or the a priori definition of groups can be said to exist and be defined in advance before study. But knowledge about links, power relations and interactions between people and things must emerge from the field, leaving actors to define themselves and interpret the network and settings in which they are located. Actors act as mediators. They continuously transform the elements they are supposed to carry and therefore their specificity needs to be accounted all time. Every actor is made to act by many others and the agencies that play between them are always ‘accountable’ through descriptions and motivations, as a response and in opposition to the agency of other actors, and through some ‘flesh and figures’ that give them some form or shape. These materials and logics are what give form to a certain context and is what constitute a *figuration*.

‘Figuration’ endows agency with a shape (Latour 2005, 54). Not in a reductionist way, as it could be in a single representation or visual description of a network and the relations of its subparts, but it must (or attempt to) include as the many different interpretations, motivations and perspectives as the number different mediators and intermediaries that constitute a certain configuration. However, as long as these agencies and relationships remain invisible they leave no trace,

therefore they are not accountable. All infrastructures — both technical and interpersonal — inevitably tend to fall into the background of human interactions, naturalized in the everyday routines of social interactions, becoming invisible. Thus, Latour argues, if we want to have a meaningful argument about a situation or configuration, certain actions and performances are necessary to expose these agencies and connections between inanimate and human actors.

This means we need to find ways to make people and matters ‘talk’, altering the apparent stability of a certain configuration, habits and social constructions, in order to make exceptions, conflicts and unexpected trails emerge. To describe what such actions might be, Latour use the term Plug-ins as a way to name interventions that function to activate something that was not possible to see before, or “plug-ins lend actors the supplementary tools that are necessary to render a situation interpretable” (Latour 2005, 209). This metaphor borrowed from computing in many ways evokes activities and tools that already belong to the design practice. Methods such as ‘cultural probes’ for instance do actually share many qualities of plug-ins if we consider their ability to alter a certain situation and provoke reflection. Nevertheless, the motivation that guided their original development was actually explicitly dissociative from the social sciences. As defined by Boehner, Gaver and Boucher (2012), probes, “were developed as a declaration of independence from the implicit requirements of social science methods in an attempt to construct a design-centered approach to understanding people and settings” (195).

In her essay “Configuration” Lucy Suchman provides an expanded definition of figuration that might be interesting from a design methodological perspective. Besides exposing the relational ties within a socio technical system of reference, what Suchman seems to address is the importance of reanimating the “figure” of a system, the logic and purpose behind its design, as a necessary activity to articulate and produce the material semiotic required for its transformation and reconfiguration: “Figuration is an action that holds the material and the semiotic together in ways that become naturalized over time, and in turn, require unpacking to recover its constituent element. It is also, however, a mode of production, as the circulation of figures implies their re-contextualization, multiplicity and at least potential transformation” (Suchman 2012, 49). Thus, by revealing the subjective interpretations, agencies and practices of actors involved or excluded by the same infrastructure, ‘figuration’ provides a possible tool to approach the design and re-configuration of large socio-technical system.

Design knowledge and infrastructures

Redesigning infrastructures is a daunting task to say the least, and to realize a new one will involve a significant range of skills, professions and areas of expertise extending far beyond the reach of the design discipline. However, design might play an important role in the process of re-thinking them. Multidisciplinary, open and systemic approaches, that are attentive to diversity and plurality of interpretations are necessary when dealing with broad and complex socio-technical systems, and it is in this context that design discipline can find a possible leading position. Due to its knowledge about how to articulate issues through materials and make solution to complex problems experienceable, design seems the ideal candidate to provide the means to understand how to re-animate the figure and reconfigure industrial infrastructures opening them up to variety interpretations.

For instance, within participatory practices ‘design games’ have been historically developed as material to allow stakeholders with conflicting interpretations of a problem to share a common understanding of it and to collaboratively explore alternative solutions to matters of concern. As illustrated in the previous section of this thesis design practices are continuously evolving including a variety of methods aimed at dealing with the constantly increasing complexity of technology and society. Different approaches have been experimented with, including means to anticipate and explore the possible uses and mediations of technologies in their context and tools to engage publics in a discussion about matters of concerns. Drawing from this rich background can provide us with a starting point from which to build upon and to develop new approaches necessary to first render infrastructures accessible and available as material for design and participation.

Design’s embodied ways of knowing

In the *Reflective Practitioner* (1995) Donald Schön describes design as an embodied and situated dialogue between the material and the situation. Through a continuous process of reflection-in-action enabled by sketches, mockups and qualitatively, knowledge emerges from the context allowing designers to qualitatively evaluate different styles and configurations, to restructure problems and redefine questions. Although this definition is still strictly related to professional architect and designers producing answer and solutions, Schön description still offer a good analogy of how practice based research works.

Like similar forms of art based research, the design process does not start from the formulation of well defined questions, topics or problems, but ‘formulating a question’ implies delimiting the space in which a possible answer can maybe be found through making and prototyping. Artifact and art interventions used during the design process are both tools to explore and to investigate a specific area as much as they are an outcome and a possible solution to it. According to the professor of Research in the Arts Henk Borgdorff (2011, 60-61), they embody the fundamental ideas and perspectives that “disclose the world for us and, at the same time, render that world into what it is or can be”. Thus design offers us the means to investigate futures and alternatives by allowing new experiences, as “outlooks and insights that bear on our relationship to the world and to ourselves”, affecting “the foundations of our perception, our understanding, our relationship to the world and to other people, as well as our perspective on what is or should be” (61).

Central to this process is the concept of embodied knowing and the recognition of how people construct their own understanding of the world through their bodies and sensorial experiences (Johnson 2011). This perspective is largely drawn from Dewey’s notion of ‘experience’ as fundamental source of knowledge (Dewey 1987) according to which there is an emotional, intellectual and practical unity that characterizes and renders them inseparable from the everyday life. By crafting ‘experiences’ a designer can make the different qualities and relations of a ‘problematic situation’ present and enactable, exposing the possible limitations that existing socio-technical habits and configurations might exert on the achievement of qualitatively preferable ones. Through this process of doing and undergoing, new knowledge is constantly produced, changing our understanding of an existing situation and producing the foundational new possible design interventions and configurations.

Although an appropriate philosophical distinction from the previous pragmatist views is necessary, Maurice Merleau-Ponty (1968) also addressed attention to the structures of experience and subjective consciousness about the interactions between people, places and things. In particular, Merleau-Ponty suggests how the relationship between humans and non-human actors cannot be fully described orally or as a priori, but always entails contextualized ‘palpable’ qualities. People, things, nature and the environment are mutually influenced by each other’s presence, by “acting and being acted upon”, sensing and being sensed at the same time.

Materializing networks

Design research and practice have developed a strong competence and a variety of tools to conceive and support the introduction of more sustainable and inclusive systems of product and services. This subchapter provides a description of a set of existing approaches dealing with the design and materialization of socio-technical systems and infrastructures we might need to relate to, considering some the environmental purposes and social implications that working with infrastructures implies. The aim of this exercise is to identify a set of tools to reveal and give a presence to existing networks of infrastructures and to identify possible methodological frameworks through which to possibly understand how to work with this material once made available. Different methods are here critically addressed and analyzed in order to expose some possible issues requiring more attention. In particular we'll here discuss what kind of information they provide; where they concentrate their actions, what they do actually reveal and render known. A methodological gap is finally identified, offering a possible ground and starting point to propose a new possible practice based approach to understanding how to enable user-led innovation for existing networks infrastructures and services, and to curate their transformation.

Co-design and participatory approaches

Participatory and co-design methods allow designers and researchers a deeper understanding of future users, fostering inclusiveness and diversity of interpretation in their process. Due to their capacity to provide more user centered solutions by better interpreting users' contextual needs, these practices are now also largely employed to guide the design and introduction of ICT applications and planning of infrastructures (Schaffers, Ratti and Komninos 2012). 'Design games', speculative designs and participatory sensing approaches are all methods largely employed today in a variety of ways to engage participants in a discussion about present issues and future possibilities in the early stages of the design process (Binder et al. 2011; Burke et al. 2006; Sanders and Stappers 2014).

The tools employed can be low tech, such as board or a role-playing game, or high tech, such as sensor probes or interactive devices, and they can be aimed at understanding present issues as well as to explore and speculate about future possibilities within workshops and fieldwork sessions. Despite these differences, these mockups and artifacts always have the same function: they offer the dialogical means to relate and enact socio-material configurations, allowing

designers to address questions, filter information and to explore a design space. For instance, ‘design probes’ are today a common tool to engage participants in expressing their needs and triggering their reflections about their context and practices, as ways to inspire designers expanding their views (Boehner, Gaver and Boucher 2012) or as premises to participatory sessions (Mattelmäki 2005).

Participatory practices are now well established within the corporate and consulting environment as a means to ensure usability and provide users better product experiences (Hunt 2011). However, as cases like the Medea Living Labs in Malmö demonstrate, these approaches and methods are now once again taking a political stance, engaging communities with matters of public concerns, improving social awareness and experimenting in new ways of making and producing knowledge on a local level. This way of working challenges prevalent homogenizing and centralized top-down decision making process typical of corporates and policy making, taking into account the agency of their designs and the designer’s responsibilities for her own actions.

Beside the undoubted richness of this approach and the admirable social and political commitment of many of these actives, we can still point out some practical limitations that demand attention. Independently from the extension of the project and commitment to the stakeholders, co-design practices concentrate much of their activities at the front end of infrastructures and within a design space already shaped and defined by established hierarchies, policies and infrastructures. Relations and interactions among users and companies are reframed to provide more inclusive solutions at the fringes of infrastructures, but it does not really affect fundamental power relations.

Social innovation activities from the bottom-up still produce solutions within the gaps left open by other governmental institutions and infrastructures. Within this frame participants and designers are rarely aware of the dispositions and operations of institutions and infrastructures that produced the context in which they operate. Thus this work might actually run the risk to be legitimated as a way to explore new kinds of ‘markets’, outside what is normally considered to be one. There is, in fact, a resilient tendency to categorize individuals within preconceived functional groups — ‘teenager,’ ‘immigrants,’ ‘unemployed’ ‘makers’ ‘neighborhoods’— whose dynamics and issues can be possibly addressed and formalized through design. A categorization that might contrast with the necessity of stating individual differences as undeniable starting point for knowledge production and

strike with some of the feminist techno-science perspectives at the roots of these practices (cf. Haraway 1994).

System design for sustainability

System Design for Sustainability can be defined as a service innovation strategy aimed shifting the business focus from designing and selling physical products only, to selling a system of products and services (PSS) jointly capable of fulfilling specific client demands (Manzini, Collina and Evans 2004). The approach is the result of an increasing awareness about the limits of product innovation and eco-design strategies (e.g. life cycle analysis) in ensuring sustainability. Thus, the need to develop broader strategic methods aimed at changing society's consumption behaviors towards sustainable forms.

Firm analytical methods and strategic design tools have been developed to guide designers in the creation of sustainable production-consumption system and evaluate their improvement compared to current state (Vezzoli, Pruul and Coad 2010). These include, service interaction storyboarding, systems maps, web tools and guidelines to ensure the system's social and environmental sustainability and stakeholders' convergences of interest charts. The necessary knowledge to design these systems usually comes from the interaction with communities and stakeholders, thus participatory methods are also often included. Recent research on sustainable product service systems is now addressing the knowledge gap regarding the mechanism and factors driving the implementation and diffusion of this kind of innovations in the real world through transition management strategies (Ceschin 2013; Vezzoli, Ceschin and Kemp 2008).

This approach proved to be successful as it provided companies and designers with a set of tools to guide them in the non-trivial process of understanding how to configure and implement socially and environmentally sustainable system and solutions. At the same time, cases of companies converting to PSS approaches exist and several examples of bottom-up system innovation adopting its methods are available. However, beside the usefulness of this perspective in showing that alternatives to mass markets and consumption do exist, what seems to be a lack is an ability of this approach to address questions regarding the experience of these system innovations once implemented (Verbeek, 2006), along with its incapability to anticipate the possible systemic consequences of their agency and growth before they are actually implemented.

PSS illustrate how more sustainable and flexible production and consumption systems are indeed possible to conceive and to implement. However, questions remain unsolved regarding how to avoid bottom-up innovations framed and integrated within the existing capitalists logic of growth (Fry 2009, 151-155). In many cases, system innovations happen at the front-end of existing systems (cf. Morelli 2007) or at the 'niche' level. Small socially driven businesses and start-ups develop, fulfilling needs that existing services and infrastructure cannot meet, filling the gaps they leave open. Within the current paradigm, set up to serve scale and mass manufacturing, these small-scale initiatives struggle to manage and maintain their business models and supply chains. Their only option then becomes to find compromises, to scale-up or to be absorbed by bigger companies, limiting by de facto their reach and sustainability.

Participatory sensing and infrastructures' augmentation

With the diffusion of mobile phones and the growing affordability of embedded sensors and systems, participatory sensing emerged as a way to form interactive, participatory networks that enable public and professional users to gather, visualize, analyze share local knowledge (Burke et al. 2006). Due to their affordability and ability to reveal hidden aspects of everyday life, sensor probes have been often employed in participatory design as a tool and a method to engage citizens in the collection of data about their cities and to create their own rationale about matters of concern, such as air quality and traffic density (DiSalvo et al. 2008; Kuznetsov and Paulos 2010a). In addition, several examples of grass root initiatives, or socially driven services and collaborative sensing networks where citizens produce and share information and resources about and within their cities and communities are available (Townsend et al. 2011).

Recent experiments and projects have been also dealing with citizens' exploration of large-scale industrial infrastructures and their relation with informal bottom-up communities through methods of infrastructural augmentation. Augmentation consists of adding information processing and ability to generate data to objects and systems unable to produce them, providing enhanced possibilities for experiences and interaction with their users (Kuniavsky 2010). In the MIT Senseable City Lab 'Trash Track' project citizens have been invited to help exploring how the waste collection and recycling system of their city was operating. Different types of trash have been 'augmented' and equipped through small location aware devices enabling the system to produce information it

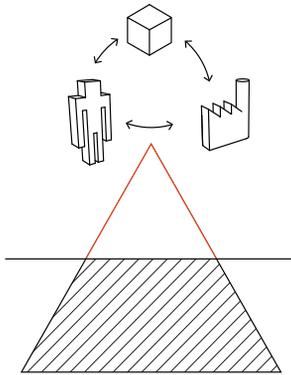
could not otherwise provide. As a result a map of unknown aspect of a large urban networks like waste removal was produced and made available to citizens, companies and academics for judgment, analysis and research (Offenhuber et al. 2012). In a similar way, in the project 'Forage Tracking' instead, GPS devices have been used within a participatory design process to reveal the functioning of informal recycling cooperatives and to facilitate their interoperability with public and private institutions (Offenhuber and Lee 2012).

These projects open up new opportunities and offer a glimpse of what methods and tools could be used to explore for allowing access to infrastructures. At the same time they offer new possibilities to study and engage with large existing physical infrastructures and identify opportunities to relate and makes sense of large-scale systems dynamics otherwise impossible to grasp. This is because technology does have the ability to describe and present world and its phenomena differently. At the same time though, we should be aware of the political implications of these projects and what is that is actually revealed and how.

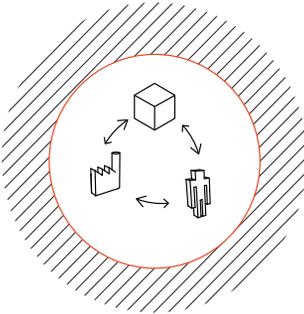
Beside possible observations on the politics of representations and data used in these projects (cf. Suchman 1995), what is interesting to notice here when looking at the examples provided is that functionalities and operations of the large 'formal' infrastructures always remain hidden. Participatory sensing is used as a mean to reveal and incrementally render accountable something unknown at the front-end of existing infrastructures, in a top-down manner, to produce information with a level of detail and granularity their measurement instruments can not typically produce; to reveal, formalizing it, something unknown from the bottom-up; or to reveal an informal social organization in order to generate new synergies between it and existing formal infrastructures. Nevertheless, protocols, materials and logics of the systems that actually determined a certain situation and design space still remain concealed and unquestioned.

Counteracting invisibilities

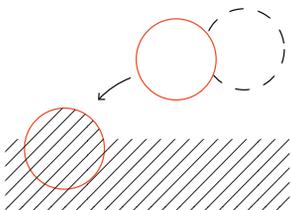
From the different approaches described and case studies mentioned, what is apparent is that these methods and approaches are generally located at the front end of infrastructures, aiming for a basic understanding of the existing configurations as a starting point for design. Thus, such processes run the risk of not being able to address the underlying functioning and logics of the infrastructures shaping the design space. Standards and protocols driving formal institutions



1. User centred and co-design approaches limit their action at reconfiguring interactions on the top of existing industrial networks and infrastructures.



2. Niche and bottom-up initiatives make something transparent by showing radically different ways of doing and solving problems, creating new infrastructures.



3. Bottom up and social innovations render something new and 'informal' transparent and available. This can then be incorporated within existing industrial structures, their protocols and practices.

are never accessible to participants and designers for judgment and are always taken for granted. Rather, most of the time are yet uncontrolled and unknown phenomena at the fringes of infrastructures that are revealed and rendered transparent.

This way of designing and working with system and information it can be argued, still pretty much conform with the industrial way of design and look at the world as described by Heidegger (1977) and Borgmann (1987), since it produces, intentionally or unintentionally, commodities. Bottom-up innovation, informal organizations, sensing networks and start-ups all render transparent and available something, such as new information or a new way of doing or fulfilling a need, which might have some value for some other actor, company or institution. Once made accountable, niches and bottom-up innovation become formalizable and possible to integrate within the existing paradigm, its infrastructures, protocols and logic of growth. This ‘enframing’ process often ends up changing the social and sustainable qualities of bottom-up innovation. If we want to maintain these qualities instead, by shifting the way society and infrastructures functions systematically, we need to reverse this process directing by spotlight towards infrastructures rather than outside them.

The inability of current methods to actually provide the means to relate and inquire existing networks and organizations that frame the design space represents ‘a gap’ between them and this present research questions. Only by addressing the required changes within these networks can we understand how to purposefully apply technology and support the diffusion of more sustainable and people-centered ways of making and doing without replicating previous mistakes or come to compromises. Thus, the designers’ attention needs to shift from the design of new systems of products and services on the top of existing networks to infrastructures and their foundations.

We can therefore start outlining what a possible redirective and transitional practice might look like and what tools it could include. The basic premise behind this work is fairly simple: since the first obstacle is one of accessibility, this is where we need to start — to materialize that which is otherwise hidden in order to make it available as material for design. To reanimate the figure of infrastructures, tracing their present working and agencies, it’s a necessary first step to counteract their naturalization and activate the agencies of their different mediators and actors. Then, after materialization, we can start exploring what practices

are needed to enable change within current configurations and to create new forms out of this material, opening up for participation and allowing citizens to construct their own rationale regarding these ‘infrastructural matters of public concern’ (cf. Haque 2010).

Indeed there is a solid ground of design methods and approaches from which to build upon for this scope. For instance, augmentation and participatory sensing provide the means to render visible networks otherwise impossible to relate to, while system design and scenario approaches offer the necessary tools and knowledge to conceive more sustainable solutions and services. Finally, speculative designs and participatory ‘infrastructuring’ practices allow for the expression and investigation of possible future configurations and their mediations in their context of use.

A programmatic framework

As a way to guide actions and systematically inquire into the field of infrastructures, I will here draft a possible programmatic framework for a redirective design practice aimed at engaging publics with infrastructural issues through the materialization of present and alternative future configurations. The basic idea behind the definition of a program is to frame a possible design space within which to experiment and explore an original hypothesis (Binder and Redström 2006; Redström 2011). In this case, that the diffusion of more sustainable and distributed models of production and services supply requires a new type of infrastructure, a ‘transtructure’, to properly support their supply chains and operations. Nevertheless, this design is not achievable through established ‘industrial’ processes. Hence, there is a need to explore what kind of practices might be necessary for this purpose.

The purpose of this initial program is therefore to research and evaluate a set of design experiments and interventions of what a transtructuring practice to possibly configure and set into being transtructures might look like. This means not only to investigate ways to properly attune this new type of socio-technical arrangement to always different contextual needs, but also to acknowledge what changes it will require on behalf of the industrial systems across which it will operate to properly support its development. Considering the groundwork nature of this inquiry, design experiments will be therefore used more as way to know what is important about the original hypothesis and research questions

rather than reject or affirm them. The wish is that this very initial program could possibly open up an interesting design space where further and future developments are possible, providing a glimpse of what a transitional and redirective practice for the design of transtructures can be, and the type of forms it could produce.

This first experimental program is built on two main themes:

- Making the *infra*-structural available as material for design.
- Prototyping and staging of futures concepts.

In what follows I will provide a description of the revealing, tracing and staging activities that constitute it and its general structure. This process is not linear and every one of the activities it includes should be adjusted to the contextual contingencies, qualities and kind of infrastructures addressed. By making it explicit it is a way to invite others designers and researcher to adopt it and rehearse it, exploring its potentials and limits in different contexts and within different kinds of infrastructures in order to expand and validate it (Seago and Dunne 1999).

1. Revealing: To trace and materialize the present working of infrastructures can be fundamental to allow citizens to construct their own rationale regarding matters of public concern (DiSalvo 2009). However, to open up infrastructures for re-interpretation and design, we first need to make them relatable understandable reanimating their figure. This means exposing the logic, materials and purpose behind their design, but also their dispositions and the different practices they include and support in different places and locations. Thus, the first thing designers need to figure out is how to properly visualize and materialize this work and make the back-end functioning of an infrastructure available for discussion and judgment. These can be done in multiple ways according to the specific contextual design needs and level of access to information e.g. is there support of a company or not. When direct access is not available, 'hacking', intended as provocative act moved by curiosity and the desire to amplify the interaction with the world and without destructive intent, is an approach that may well fit this purpose (Von Busch 2009). Mobile, DIY electronics and off-shelf devices can be used to augment and visualize infrastructures, such as in participatory sensing practices related to infrastructures (Shilton et al. 2008; Offenhuber and Lee 2012). Other forms of exploration instead could include different activist practices

and repertoires aimed at exposing the figure and disposition of infrastructures and that can be adopted according to the circumstances. For instance ‘infiltration’ could be used as a possible tactic to explore sites and retrieve information and material through active presence¹⁶. Many other different techniques can be used for the same purpose. In her book *Extastatecraft* for example, Keller Easterling (2014, 211-238) offers an account of several possible non-conflict techniques, including the creations of fictions, gossips or forms of exaggerated compliance as ways to expose the disposition and active forms of these system.

- 2. Tracing and Probing:** Once visualized and materialized, the images of the infrastructure that have emerged can be turned into material for design and used as a dialogical means to capture the different subjective interpretations and practices of actors involved or excluded by a same infrastructure. By exposing the different representations and imaginaries of the same system, new alternative configurations become visible, opening up opportunities to re-enact relations and feedback loops differently. These accounts can be included in an iterative design process leading to the identification of appropriate shared representations and alternative preferable solutions. Appropriate tools and design can be crafted for this scope according to the context, allowing designers and participants to understand existing configurations of the infrastructure inquired and its multiple interpretations. Design tools such as ‘probes’, can be used and given to communities to reveal and expose the underlying functioning of infrastructures. For example, design kits can be crafted as a means to engage people in the exploration of the functioning, logics and disposition of infrastructures, tracing back “the origin of an issue”(DiSalvo 2009). This tactic can be employed to learn about the infrastructure and reflect about what they do, the issues they generate and what they could possibly do. Cultural probes can be also delivered to participants and members of a community as a way to expose their practices and interpretation of their contexts (Boehner, Gaver and Boucher 2012; Mattelmäki 2005). These crafts will be needed to engage users in sharing ideas and desiderata with the designers and other participants and to expand views and express the diversity of understanding regarding a specific matter of concern; materials that will then provide the premises for the re-configuration of networks and infrastructures.

16 The practice and theory of exploring usually inaccessible urban spaces: <http://www.infiltration.org/>

3. Staging in the Field: Once the existing configurations and interpretations are made present, new concepts can be collaboratively conceived out of this material. Prototypes, mockups and design fictions can be crafted and used to enhance people's creativity and materialize different scenarios and interaction between local and global systems. These can be then used to stage and rehearse these concepts in the field through open and iterative participatory processes of experimentation aimed at engaging publics in a discussion about future possibilities (cf. Halse et al. 2010). By offering an experience of a future configuration as close as possible to real life, knowledge about the possible mediations of these future configurations can be explored. On the one hand by encountering the design work, citizens can relate to this futures—breaking with their habits—compare it to their present condition and externalize their diversity of perspectives and worldviews. On the other hand, by opening up their process and work for interpretation, allowing people to openly questioning and interrogating it, designers are thereby given the tools to better interpret the possible consequences and mediation of their designs (cf. Brecht 1964; Tracy 1994). Through this dialogues, new issues, ideas, possibilities and practices can emerge. This can be then further explored by the designer and addressed through different aesthetics and prototypes, allowing designers to probe into a context and its communities, understanding how to curate or re-purpose their plans and designs according to them (cf. Redström 2008; Tonkinwise 2011).