Prototyping Digital Sovereignty

Experimenting with Community Wireless Networking Technology

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Introduction

The term "digital sovereignty" has percolated in the last decade in academic and policy debates as a prescriptive normative term to describe various forms of autonomy, self-determination and independence in relation to digital infrastructures, technologies and data.[1] While territorial perspectives on the term are prevalent,[2] understandings of digital sovereignty as digital *self-determination and autonomy through collective control* are increasingly articulated by civil society entities and social movements.[3] Closely connected to social justice narratives, such concepts of digital sovereignty often stipulate social

1 See the Chapter "Digital Sovereignty" by Pohle and Thiel in this volume.

2 Through the established nation-state perspective, digital sovereignty conveys state protection of citizens' privacy rights versus other states (Couture 2019; Floridi 2020; Pohle 2020; Thiel 2019), as well as defending democratic procedures against external manipulations through curtailing or countering disinformation campaigns (Thiel 2019). A second strand focuses on the recalibration of power between the public and private sectors by restraining corporate control over the development, deployment and management of digital infrastructures, data and analysis (Floridi 2020; Pohle and Thiel 2021; Thiel 2019).

3 It is set closer to ideas such as "food sovereignty" coined by Via Campesina at the World Food Summit in 1996 (Anderson 2018).

control over technologies and digital infrastructures, spotlight the development and use of digital tools that are conceived within community ecosystems and aim at raising community awareness, fostering digital participation and the appropriation of technology (Couture 2019; Haché 2014). In the following, we explore whether and how DIY and open-source technologies in participatory design practices can produce the social and political spaces for advancing a community-driven imagination of digital sovereignty.

This chapter offers a case-study analysis of a collaborative prototyping process in the framework of the MAZI project – a three-year EU-funded research aimed at creating techno-social infrastructures for digital sovereignty, with case studies in three major cities – Berlin, Zurich, London – and in several towns in rural Greece.[4] This paper focuses on MAZI's Berlin chapter. The overarching objective of MAZI (meaning *together* in Greek) was to develop interventionist methodologies that address the increasing corporate centralization of digital infrastructures and the uniform modes of digital interactions that emerge as a result of the steady closure of digital ecosystems. The idea of digital sovereignty within MAZI focused explicitly on open-source community wireless technology (CWN) that is developed and used within hyper-local settings, at the scale of neighborhoods. It aimed at creating interdisciplinary spaces for questioning the underlying social and political assumptions and biases that structure network technology itself; through that, it collectively explored what the notion of community-led "digital sovereignty" might actually mean in practice. In Berlin, the experimental orientation of the MAZI project meant that technical and design decisions in developing the hardware and software for CWN were kept open, allowing for a meaningful collaborative process. A participatory prototyping process was planned for translating "big" questions on the meaning of digital sovereignty into hands-on engagement and encounters.

This orientation draws on a growing body of literature in sociology, anthropology, design research and science and technology studies (STS) that expands the notion of prototyping beyond simply a technical process for the development and design of technological

4 MAZI was conducted between the years 2016–2018 and received funding from the European Union's Horizon 2020 ICT CAPS initiative under grant agreement no 687983.

objects[5] (Guggenheim 2014; Jimenez 2014; Kelty 2010; Lezaun and Calvillo 2014; Marcus 2014; Suchman 2000). Research in these fields delves into the social and political role of prototyping, or technology-in-the-making, for developing material forms of participation and democratic practices.

The social and political potentials of prototyping have been advanced particularly since the 2000s, when the development of interactive products, such as mobile devices, laptops and interactive games, created a need for rapid processes of interdisciplinary design and engineering. Prototypes play a central role in those processes (Bogers and Horst 2012; Kurvinen, Koskinen, and Battarbee 2008). As Suchman et al. (2002) show, interdisciplinary reconstructions of prototypes allow for the development of innovative processes that transform the focus on invention as a singular event to its reconstruction as diverse collaborations across different social environments.

Such analyses pointed out a shift of attention from prototyping artifacts to prototyping processes through "ongoing practices of assembly, demonstration and performance" that reconstruct human actions and reconfigures social and material relations (Suchman, Trigg, and Blomberg 2002, 163–66). This has gained particular momentum in the past decade with the proliferation of information technologies and digital networks. In particular, open-source technologies as well as the re-emergence of DIY and hacking practices seem to radicalize the proclaimed democratization of technology. As many have shown, open, collaborative and generative processes of prototyping can serve as sites of knowledge co-production and knowledge commons (Benkler 2006; Kelty 2008; Powell 2012). But at the same time, they may obscure conflicts and perpetuate socio-economic power structures (Tkacz 2014; Lanier 2006; Turner 2010).

In this case study analysis, we flesh out some of these conflicting consequences of openness by focusing on the inadvertent results of open processes and emphasizing the need to connect between openness and accountability to the shortcomings and inherent failures in the context of experimental realms. Our analysis is threefold, we critically examine and reflect on 1) the potential contradictions between experimental realms and normative expectations,

5 A prototype is an initial model of a product, object or design that is still in stages of development, open for rethinking and iteration (Hackney and Manar 2015).

2) potential collision between different epistemic systems that may exclude or alienate participants, and 3) the question of sustainability within project-based interventions. We argue that, for advancing community-driven futures of digital sovereignty, it is crucial to treat such troubles and conflicts not as obstacles we should simply get rid of or solve. Rather, they must be seen as the living materials of technological development that engages with ideas of democracy – indispensable for politically conscious design concepts and tools.

MAZI: Community wireless technology in Berlin's urban space

Information and communication technology (ICT) has become strongly commercialized and centralized by a few, quasi-monopolized technology corporations (Floridi 2020; Pohle 2020; Pohle and Thiel 2021, upcoming). While individuals and collectives are benefitting from the expansion of globalized ICT, they are often stripped of rights and political agency in regard to ownership and control over data. The power of technology corporations lies not only in controlling the back-end design of data infrastructures but rather in the highly specialized capacities to aggregate massive amounts of data and to analyze them in order to produce new kinds of knowledge (Boyd and Crawford 2012; Mayer-Schönberger and Cukier 2013).

CWN technology evolved alongside wireless networks and it demonstrates a rich history of applications on various scales. Examples range from the Dead Drops by Aram Bartholl who simply plastered USB sticks into cracks in public spaces, creating very local networks;[6] the Pirate Box, which allowed NYU students within the lecture hall to share files without breaching copyrights policies;[7] to collectively owned and managed wireless infrastructures, such as, Freifunk in Berlin[8] or the Metropolitan Wireless Network in Athens – one of the largest networks in Europe with 30,000 private antennas connected.[9] It has become relatively easy to develop a personal network, since the necessary hardware is affordable and the software

6 https://arambartholl.com/dead-drops/.

7 https://piratebox.cc/start.

8 https://freifunk.net/en/.

9 http://www.awmn.net/content.php?s=9fc8551534eefe7780d6e9f10b557103.

has been made available through massive documentation of open-source communities of practitioners. Still, there are many socio-economical and material barriers to those who are not technologically savvy, or don't have the time and resources that technological participation require (Rumbul 2015; Haklay 2013).

MAZI Berlin constitutes one example of a range of projects that seek to advance democratic and bottom-up approaches to prototyping technology.[10] In the coming together of design and open-source culture, collaborative forms of prototyping turn both the prototype and the design process into a continuous state of "perpetual beta" (Unteidig, Calderón Lüning, and Dominguez-Cobreros 2017). This is where experimental or unstable versions of the design are released for use and at the same time continue to be in processes of development and documentation that are maintained by the community of users. This circular movement of open-source techno-social development has been analyzed by Christopher Kelty (2008, 4) as the "unprecedented forms of publicity and political action" of free software and other similar and related projects that emerge from it. Kelty's articulation of the politics of open source cultures is particularly relevant for imagining community-driven digital sovereignty. It brings forth the idea of Free Software as a "public" that is concerned with its legitimacy and independence from state-based forms of power and control, as much as corporate, commercial and non-governmental power (Kelty 2008, 9). Recursive publics, he explains, focus on the radical technological modifiability of their own terms of existence.

The MAZI Berlin project was premised on the imagination of open-source, recursive publics, but it had to grow a community that would put this imaginary into practice. As such, it first had to address the aforementioned problem of alienation and access by designing a toolkit that provides low-barrier accessibility to both the technology as well as to the terminology and discourse around it. The initial prototype of the "toolkit" has been deliberately designed using open-source and off-the-shelf components including Raspberry Pi[11]

10 To name a few: Subnodes by Sarah Grant (http://subnodes.org/); Open-source urbanism (Jimenez 2014); The Civic View from Above (Keysar 2018); Decidim in Barcelon (Aragón et al. 2017); Public Laboratory for Open Technology and Science.

11 Open source, modular, single board computer that was adopted widely for community use and education: https://www.raspberrypi.org/.

and SD cards (see Fig. 1). The software was developed in part by the project partners while integrating existing Free/Libre/Open Source Software (FLOSS)[12] to create a "plug and play" installation allowing for an easy-to-use local digital network with some pre-set applications (frontend depicted in Fig. 2).

These technical elements were accompanied by documentation of use cases and experiences as well as other physical materials such as posters, guidelines and storytelling pamphlets. All these elements, in sum, contributed to the "MAZI toolkit" (see Fig. 3).

The process of conceptualizing, designing and developing these elements took shape in various academy-community partnerships, and also emerged from dialogues between the pilot groups in Zurich, London, in several towns in rural Greece, and Berlin. The MAZI Berlin pilot was led by the Design Research Lab at Berlin University of the Arts (UDK) with the participation of local urban-activist initiatives, and was facilitated by the NGO Common Grounds and its educational

Fig. 1 The technical artifact is made up of a RaspberryPi, an SD card and battery. Different casings and ways of attaching it to places have been experimented with throughout the various use cases. The solutions depicted here highlight the versatility and portability of the toolkit. Design Research Lab.

12 https://github.com/mazi-project/guides/wiki.

platform "Nachbarschaftsakademie" (Neighbourhood Academy).[13] The main objective of the Berlin pilot was to advance discourses and practices around the idea of digital sovereignty with a strong focus on the urban: to address the individual and collective freedom and right to actively partake in the shaping of digital realities; to interpret, define and become involved in the construction of discourses and imaginations about community-driven, digitally mediated futures and, particularly, to look beyond commodified narratives of the smart city.

The main element of the MAZI project, the toolkit, brought together different groups who were interested in the possibilities of CWN tech; however, it was the main locale chosen for MAZI Berlin, Prinzessinnengarten, that played a significant role in bringing together a diverse group of people. Prinzessinnengarten is an urban community garden in Kreuzberg that envisions and develops a collaborative and protected space for learning ecology, conviviality and self-organization. It is also the Neighbourhood Academy's space of

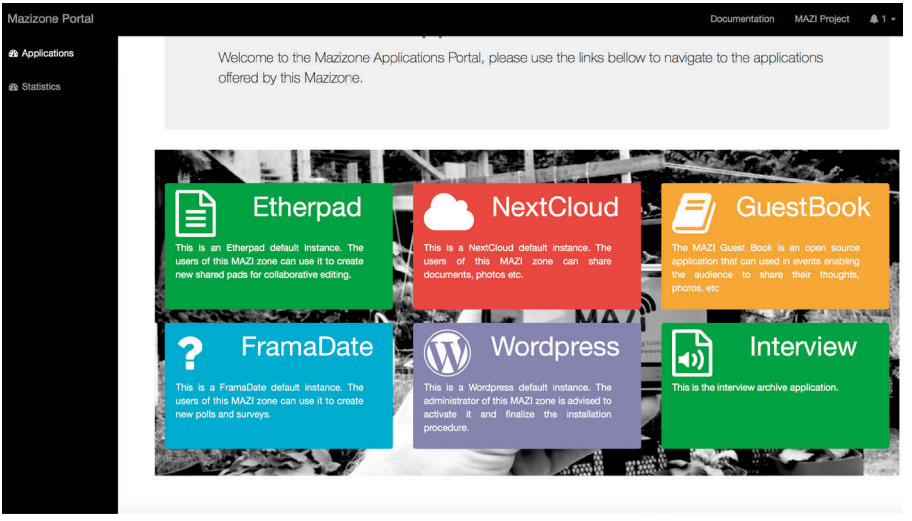

Fig. 2 The default front-end encountered by users of the toolkit after installation. MAZI project.

13 The Neighbourhood Academy, existing since 2015, is a self-organized open platform for urban and rural knowledge sharing, cultural practice and activism.

activity, a learning and knowledge exchange platform.[14] The participants in the project included activists, artists, researchers, designers, engineers, social workers and local community members, all involved in one way or another with the Neighbourhood Academy[15] and actively engaged in issues related to urban ecology and "the right to the city" in Berlin.[16]

With this social and spatial infrastructure as a starting point, the prototyping process was designed and implemented in three phases: first, community outreach and finding common ground for collaboration;[17] second, igniting the collaborative development of the CWN technology and adapting it to local context;[18] third, deploying the technology with partners in different settings.[19]

Phase 1 – Creating common grounds for collaborative technological development

The first phase of the MAZI Berlin pilot project aimed at situating and connecting the topic of CWN within the discursive realm of the participants. Two workshops were planned and held introducing the MAZI project and DIY networking technology. The first workshop centered around the idea of "collective learning," a concept introduced by the Neighbourhood Academy to understand urban activism as a form of emancipatory learning. It sought to identify shared interests and to discuss the relations between technological engagement and activism in the city, grow trust, social ties and to share different perspectives on what DIY networking is all about. The shared interest in urban ecology and the broader urban issues that mobilized the different groups that participated created a basic level of trust and a backbone for collaborative and experimental work. Urban topics such as

14 https://prinzessinnengarten.net/de/home/.

15 For a list of the initiatives that participated see footnote 21–23.

16 The term "right-to-the-city" coined by the sociologist and urbanist Henri Lefebvre (1968) in the aftermath of the Parisian occupation, was argued as the "right-of-non-exclusion" from the qualities and services of the urbanized society and as a call to reclaim the city as a co-created space (Holm 2011; Lefebvre 1996).

17 An exact division of phases in time periods is artificial since the phases partly overlap and are to certain extent on-going. Nevertheless, a rough division can be made. The first phase was mainly based in the first six months of 2016.

18 From July to August 2016 with continuous reiterations and improvements.

19 Throughout the project starting in January 2017.

Fig. 3 The toolkit also comprised information materials such as posters, handbooks and storytelling pamphlets. MAZI Berlin.

Fig. 4 The first community workshop introduced the idea of MAZI to a range of different stakeholders. MAZI Berlin.

land grabbing, financialization and new contested urban governance models for city planning echoed with discussions and issues within critical technology discourses that stand against the anti-democratic dynamics of privatization and centralization. The second workshop shifted to discussions on the technological aspects of the project by collectively brainstorming ideas about DIY networks and their potentials for digital self-determination.

Phase 2 – Collaborative development of technology

As part of the second workshop, initial technological ideas were formulated around the needs, wishes and desires related to matters of concern brought to the table by participants. With the help of quick and loosely structured prototypes (storyboarding, paper prototypes, click dummies, etc.), participants developed potential use cases for MAZI Zones in different settings. In this context the idea of "MAZI Zones" was formulated; it articulated a plan for multiple adaptations of the toolkit in Berlin to be contextualized, deployed and governed by the various initiatives, with technical and design assistance by the MAZI Berlin project team. Subsequently, the physical presence of the Neighbourhood Academy at Prinzessinnengarten was envisioned as the central hub and platform, on which experiences and learnings from the different MAZI Zones in the wider urban landscape of Berlin were to be collected and synthesized. To this end, the "MAZI Archive" software was developed by the Berlin lead pilot-team with the goal to locally collect and disseminate user-generated content within the MAZI Zone. Therefore, the particular MAZI Zone at Prinzessinnengarten acted both as a local hub and as an access point for visitors and users to get to know the project in general. It brought together issues and experiences from other hubs, and also offered more general opportunities to learn about CWN technology, the people, and activities behind it.[20]

20 The software, "MAZI-Archive", was hosted on a hardware setup consisting of a Raspberry Pi 3 (with a 16GB SD-Card), TP-Link TL-MR3020 Wi-Fi Router and an Anker Battery Pack. The router supplies an open Wi-Fi with the SSID "MAZI Archive," which serves both for the data to be submitted by the recorder-application as well as an access point for users to interact with the content. After some testing in different settings, the MAZI-Archive application was integrated to the default version of the broader MAZI platform.

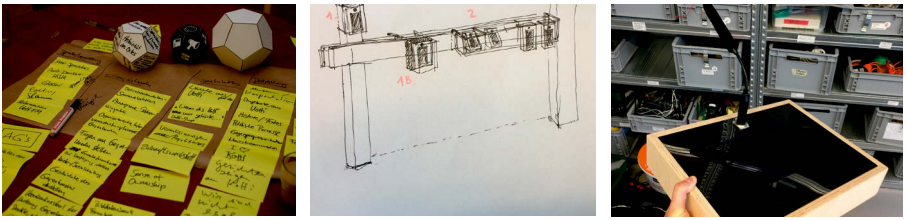

Fig. 5 A large number of prototypes, sketches and discussion prompts helped facilitate the participatory process throughout the project. MAZI Berlin.

Phase 3 – Deploying MAZI-Toolkit in multiple local setting
Aiming for openness and local versioning of the toolkit to make it versatile for a growing community of users, MAZI-Zones were put into use in different settings around Berlin. By the end of the project, the toolkit was deployed in thirteen different locales with the direct support of the lead pilot-team.[21] It was used as research tools for seminars by academics in university settings,[22] for communication and management in neighborhood issues by a few communities in Berlin,[23] for self-organizing in protest related events,[24] as an interface between researchers and visitors in the Berlin Natural History Museum (Rössig et al. 2018), and for exploring the interdependence of digital tools and social innovation by the German Federal Ministry of Environmental Protection.

The wide range of settings in which MAZI Zones were implemented required a continuous process of development and production of supplemental documentation and tutorials that would fit various contexts, stakeholders and objectives. Most deployments started with a specific workshop format developed within the MAZI project called "unboxing," where the toolkit was unpacked in order to let the

21 In addition to that, several independent deployments of MAZI Zones across Germany and abroad (e.g., in Togo and Israel) have been informed by the activities of the Berlin pilot process.

22 Alice-Salomon-Hochschule and Chair for Urban Design Technical University Berlin and University of Arts in Braunschweig.

23 The Neighbourhood Academy, ZK/U – Centre for Art and Urbanism, the Commons Evening School and the neighburhood centre Kiez Anker 36 in Berlin Kreuzberg.

24 Bizim Kiez, Park Academy, Stadt von Unten, and the Anti-Google-Campus Initiative all active in the neighborhood of Kreuzberg-Friedrichshain in Berlin.

participants get to know its components. Participants were introduced to the MAZI project, followed by a demonstration of a pre-installed MAZI Zone and a guided process in which each person assembled and configurated their own personal MAZI Zone. Through hands-on engagements participants could see, touch and interact with the different components of DIY wireless network technology and develop a deeper understanding of both the components of the technology and the project's critical and experimental approach.

Fig. 6 Installation of a permanent MAZI Zone in the Prinzessinnengarten (left). Visitors interacting with the MAZI archive sound installation (right). MAZI Berlin.

Fig. 7 MAZI Zones have been used in other context, e.g., for installations at the Berlin Museum für Naturkunde (right) or the Venice Architectural Biennale 2017 (left). Design Research Lab.

Fig. 8 In "un-boxing" workshops, participants were guided through the process of assembling and installing their own MAZI Zones. MAZI Berlin.

Discussion: Fleshing out the troubles of openness

The core motivation for the MAZI project, as mentioned earlier, centers around the development of digital self-determination and autonomy through collective control over technologies and data in the city. While the "right-to-the-city" discourse raises demands for democratic participation in the production of urban space, the topics under discussion in MAZI evolved around similar logic regarding the data-driven mediations of urban space and life. It sought to address the need for concrete and viable alternative technological solutions that would allow for a different distribution of power between users, developers, administrators and owners of ICTs (Antoniadis and Apostol 2014).

With this in mind, the experimental aspects of collaboratively prototyping the CWN technology engaged participants in developing tools and practices that would extend their practices of urban activism within the realms of technology. Developing and using the MAZI toolkit facilitated a collaboration in which the emphasis was on the productive and not less on the processual aspects of experimentation. As Alberto Corsín Jiménez (2014) remarks, prototyping incorporates failure as a legitimate result in the realization of the process and stands for reconfiguring, at once, material objects and social relations. It is a process of trial and error, he writes, and embracing failure can allow for the emergence of inventive practices, and for new experiences and processes of democratization.

While we share these considerations, our case study analysis is set to flesh out the dilemmas and problems that might emerge within such open source urban experiments. What may be the

inadvertent consequences of challenging the rigid boundaries of expertise through open-source tools? What happens when experimental, techno-social visions are met with "old" politics, and entrenched social, political, economic perceptions, divides and inequalities? Who is accountable for the upshots of failure beyond the experimental and visionary realms of prototyping; how is failure mitigated within the realities of social context and locally situated interventions? With these questions in mind, we now focus on the tensions and troubles that came up in the MAZI Berlin project[25] and unpack some of the challenges into three categories of critique and action.

Reworking structural power relations in academy-community partnership

Comparing and synthesizing the dynamics of discourses and struggles for urban infrastructure and technological infrastructure created a space in which a diverse range of stakeholders could collaborate and engage in processes of mutual knowledge production, but it was only a first step. Academy-community partnerships bring with them some tensions; inevitably, there are potential contradictions between the realms of the research project and the expectations, responses and concrete needs brought by participants. During the MAZI Berlin project there were demands placed on the various urban initiatives that took part, to invest their time, skills and knowledges in the project. This required clarity with regard to the concrete benefits participants would gain from taking part in the project.

Over the years, the Neighborhood Academy played the role of a gatekeeper and facilitator for building productive collaborations and relationships with urban initiatives within various settings. In participatory research and design projects, the community gatekeepers play an important role, as they hold the power to allow or deny access to particular communities or institutions (Lenette et al. 2019). In the MAZI project, these roles were part of the negotiation between the UdK and the Neighborhood Academy from the very early stages.

A level of reservation toward this collaboration was evident when e.g., participants addressed the phenomenon of "academic harvesting", i.e., the one-sided withdrawal of knowledge by researchers. For

25 Related efforts have been undertaken by comparing and contrasting the Berlin and London pilots (Gaved et al. 2019).

example, one of the activists in the Neighborhood Academy mentioned the considerable and burdensome workload he experienced over the years, due to the fact that the community garden has become a popular subject of countless bachelor's, master's and doctoral theses. While the activists welcomed such collaborations (and the visibility they generate), they often experienced a lack of concrete and immediate exchange value and, in many cases, research findings and outcomes where not shared back.

Hence, a considerable level of trust had to be established within the lead pilot team before it could even advance to engaging activists from different urban initiatives. This also required a careful consideration of under-valued and "invisible" forms of labor (D'Ignazio and Klein 2016) that go into creating lasting relationships and trust throughout the communities. This initial robustness in reflecting roles and expectations, helped set a standard of reciprocity for the rest of the project. It enabled to critically rework power relations and specifically address the need for a two-way relationship to make sure that the outcomes of joint efforts are also equally distributed (ibid.).

One of the strategies developed in order to establish trust and fairness within the process was to financially compensate the initiatives participating in MAZI Berlin for sharing their expertise and insights in workshops and other events. This was accompanied with a transparent discussion on the financial structure and available funds in the framework of the project. Furthermore, the reciprocal sharing of skills and knowledges during workshops related to CWN technology constituted another aspect for creating mutually beneficial relationships of collaboration and exchange. The workshops provided the base for collectively prototyping the MAZI toolkit, but, moreover, they created a shared space for different initiatives to address and share resources, challenges and needs. Finally, the actual deployments of MAZI Zones (project's third phase) allowed the establishment of shared ownership and use of hardware and software, while providing technological support for the initiatives in their independent projects.

Between experimental realms and epistemic norms

While all these arrangements and agreements sound like solutions, tensions that stood in the way were entangled in more complex sets of epistemic norms and expectations that many times pose significant challenges in collaborative, civic and open source projects

(Rey-Mazón et al. 2018). DIY engagements in CWN is a relatively new idea for introducing the political potentials of decentralized/local ownership and management of technology and data (Antoniadis 2016). For CWN to become a tool for community-driven digital sovereignty, a prerequisite is a community-based awareness and capacity to exercise control over the development and implementation of digital technologies. Critical awareness to the patterns of corporate sovereignty over technologies and data was discussed and built among participants; however, the success of the project depended on overcoming the basic alienation most people feel toward experimental, "half baked" technology, which requires significant investment before it fully performs its tasks. The main impediment was in challenging the boundaries of expertise. The pilot team had to continuously address and deconstruct roles ascribed to them, e.g., being perceived as "experts" or "service providers" that deliver solutions in the form of reliable technologies to passive customer-users.

The tensions between users and experts were dealt with by purposefully keeping open several design decisions regarding the MAZI toolkit, which in turn allowed for a meaningful, long-term and open-ended participation and appropriation of tools and methods by the various actors who participated in the project. These questions were negotiated in situ through ongoing practices of design-in-use (Gregory 2003; Suchman, Trigg, and Blomberg 2002).[26] Such questions included: In which contexts and for which purposes can it be used? Who uses it? How is it managed? It meant that the process would be "messy" by relying on the active collaboration of participants that might feel alienated in the process. But it also meant that participants and facilitators would directly engage with the underlying infrastructures of CWN tech and develop critical thinking on the structure of technology itself. Designing a self-built CWN tool meant that the invisible decisions, ideologies and conventions of a community of practice that are embedded in proprietary technology and generally in technological infrastructures (Star and Ruhleder 1996) could be unpacked and negotiated.

26 This shift in design practices that began in the later 1990s was significantly informed by Scandinavian approaches to participatory and "cooperative design" (Bødker and Grønbæk 1991; Gregory 2003; Hillgren, Seravalli, and Emilson 2011; Kurvinen, Koskinen, and Battarbee 2008; Suchman, Trigg, and Blomberg 2002).

Relatedly, within processes of experimentation, the decision of whether the prototype should be high or low fidelity, paper sketch or material object, "messy" or "quick and dirty," does not merely relate to questions of flexibility, cost and time, but also shapes a politics to the process. It determines who can (or feels entitled to) participate in the process, what role can one play and how meaningful can one's contribution be. Therefore, taking "messiness" seriously means openly engaging with issues of ownership, authorship and control in the realms of technological development, and taking an active role in shaping its politics. Within such participatory processes, prototypes have been conceptualized as "boundary objects" (Bogers and Horst 2012; Powell 2012; Star 2010; Star and Griesemer 1989) that allow to rework the designer-user dichotomy and to mediate between different social and epistemic positions.

By embedding a critical political attitude within the process of prototyping, MAZI Berlin sought to embrace difference and conflict as resources for design while incorporating a discussion of political and ethical values as a goal in its own right (Gregory 2003). The disciplinary and epistemological backgrounds introduced by the heterogenous actors – activists, designers, researchers, neighbors – diverged widely and required mediation. While the design researchers had a strong interest in experimental work that tests different "half-baked" prototypes and cultivates openness, activists expected a certain degree of "doneness." Usually working under relatively precarious conditions toward goals that are difficult to achieve, urban political activists have little time to "stray" or "tinker" around for the purpose of mere exploration. In this regard, an exploratory, open design process with a high degree of ambiguity may very well result in antagonism and counter-productive results.

This tension between "openness" and "deliverables" came across in the inherent conflict between the realms of continuous and often strenuous processes of community activism and the structures and logics of project-based interventions. By "project logics," we refer to the often rigid structures, in which work is organized and managed in research and development projects, often adhering to (if not mirroring) the hierarchies and result-based expectations of academic institutions and funding organizations (Torka 2009). Academic and funding bodies demand the process to be structured by clear beginning and end dates, as well as agreed-upon deliverables and,

usually, a certain degree of positivistic pressure (as in the need to deliver a solution to a previously described problem). These pressures had to be continuously re-negotiated with the "messy" realities and the continuous nature of community concerns within the prototyping process. Consequently, the project partners had to identify and negotiate ways to deliver an outcome that would adhere to institutional requirements, and at the same time ensure that the MAZI Berlin project will have a lasting and meaningful effect.

Infrastructuring against the troubles of project logics

The idea of "design as infrastructuring" (Binder et al. 2011; Björgvinsson, Ehn, and Hillgren 2010; Ehn 2008; Ehn and Badham 2002) allows one to withdraw from design as a nexus of problem solving. In this case study, it allowed the team to understand the project as oriented toward long-term, complex and interdependent processes of social transformation by creating environments and tools that can be built upon one another.

To follow the aspirations of open-source culture, MAZI had to grow a community that would continue to use and maintain tools and techniques for CWN technology activity beyond the official end of the funded project. The problem of maintenance and sustainability of MAZI Berlin was addressed halfway through by the lead pilot team, who decided to shift away from a focus on project "outcomes" to thinking and developing infrastructures for "everyday design activities in actual use" (Björgvinsson et al. 2010, 43). Correlating with the idea of the recursive public in open-source culture (Kelty 2008), such an approach is oriented toward designing infrastructure that would provide support for a self-organized community around CWN technology and, more importantly, provoke its creation.

Infrastructuring in that regard included design choices on the hardware and software level that were oriented toward adaptability and ease of use; also, documentation and knowledge repositories extended well beyond technical issues in order to include storytelling of exemplary use cases of MAZI Zones and lessons learned. Furthermore, a strong emphasis was given on technical training and the careful establishment of a "community-of-practice" (Wenger 1998) that would make it possible and probable that future projects will continue growing from the infrastructures established by MAZI Berlin.

Nonetheless, on a more technical but fundamental level, long-lasting usability and necessary maintenance of DIY technologies remains a problem within the context of academic research projects. While the MAZI Berlin lead pilot team focused on certain aspects of the design and its long-lasting effect, the project's structure and logic couldn't possibly provide for upward compatibility. Continuously updating the toolkit to adapt with external hardware upgrades is an uphill battle. As a result, the software providing the base for the MAZI toolkit is not supported by current versions of the Raspberry Pi, and it is becoming increasingly difficult to acquire older versions of the microcontroller in order to use the toolkit. With no remaining funding, and the academic and technical team moving on to other endeavors, sustainability and maintenance proves very difficult. Any upgrade would merely be a temporary step towards the same problem repeating itself with the next major version update of the technology in use.

In retrospect, some of the efforts toward sustainability and longevity of the project activities indeed proved fruitful: A few of the workshop participants[27] found their own ways of acquiring funding and continuing the use and development of MAZI. On top of that, new projects in entirely different contexts have been initiated building on the toolkit and its accompanying repositories.[28] However, complexities remain and are inherent to the overarching project of community-driven digital sovereignty and the broader idea of prototyping technologies in academia-community partnerships.

27 The neighbourhood center "Kiez Anker 36" has thus far had three follow up projects: "StadtTeilen" (https://stadtteilen.org/forschung/) funded by the Robert Bosch Foundation, "PRoSHARE" (https://jpi-urbaneurope.eu/project/proshare/) under the European funding program Urban Migration, and "Kiezgeschichten" (https://stadtprojekte.org/2020/12/kreuzberger-kiezgeschichten/) financed by the German Federal Ministry of Education and research.

28 For example: Miadé (https://www.dfki.de/en/web/news/detail/News/lokale-community-netzwerke-fr-togo0/) – Local Community Networks for Togo by the German Research Center for Artificial Intelligence.

Conclusion

The MAZI project aimed at building alternative technologies co-designed in local context while experimenting with open models of ownership, governance and administration. Beyond the technical aspect, the project continuously intertwined technical activities with critical discourse on urban and technological futures. Furthermore, the MAZI project explored and documented a wide range of approaches in which technology can be conceptualized and developed through collaborative prototyping in hyper-local settings and with non-technological communities.[29]

In the MAZI Berlin case study, the curated, but nonetheless experimental phases with the self-built toolkit led participants to develop a sense of authorship and ownership in regard to network technology; it also helped reducing anxieties and reservations towards what seems to be "geeky" technology and allowed contributors to demystify the "black box" of CWN tech. However, the same successes were also grounds for some of the conflicts and tensions we have discussed. In that regard, roles, mandates and power structures had to be addressed and collectively approached as contingent objects that can be navigated, altered and adapted (Freeman 1970). This understanding is crucial in order to avoid reproducing forms of domination and to establish more horizontal systems of knowledge co-production that are based on justice and care.

The need to prototype tools for a technological and civic infrastructure correlates with current concerns with regard to the creation and management of "critical infrastructures" in the city, which are mostly expressed in relation to the risks of climate change (Klinenberg 2016). As Klinenberg and others suggest, critical infrastructures for safeguarding cities are not only about mitigating disaster damage but also about growing awareness to collective vulnerability and addressing dominant political and social institutions (Howe and Boyer 2016; Klinenberg 2016). By bringing together the discourses and practices that revolve around urban and technological rights-to-the-city, the MAZI Berlin case study experimented with the possibility of drawing invisible lines between different articulations of critical infrastructures, whether in urban, environmental, technological or

29 For an overview on the different pilot study activities see https://mazizone.net/mazi-eu/pilot-studies/.

epistemological realms. These transfigurations of urban infrastructures raise questions regarding the possible emergence of a political discourse that brings together ideas and techniques which are usually thought of and practiced in isolation from one another.

While MAZI Berlin successfully brought together discourses and practices that revolved around the articulation of urban and technological rights to the city, it nonetheless demonstrated the risks of embracing openness as a taken for granted democratic alternative. For openness to become a politically conscious alternative it must be inextricably intertwined with accountability to the potential consequences of locally situated interventions. Experimental processes might be indispensable for prototyping civically and community-oriented technologies, yet, openness and collaborative experimentation do not guarantee the advancement of digital participation, self-determination and autonomy. Our analysis of MAZI Berlin suggests that reworking the complex obstacles that stand in the way of establishing recursive dynamics of development, use and governance might open up opportunities for both political action and public discourse that problematizes and challenges the tightening, corporate control over digital realms.

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In the loneliness of our soliloquies, in our monologues, we become conscious of our own consciousness.

— Heinz von Foerster, 1989