Prototyping open digital tools for urban commoning

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The paper will discuss an experimental co-design approach to the development of a digital toolkit prototype and a resulting set of co-design principles, which are put forward as a way of infrastructuring future design of digital tools for urban commoning. Focus is placed on the case study of a commoning hub in a Parisian suburb where the toolkit was co-designed through a series of prototyping workshops, carried out with hub users and addressing key hub needs. The prototyping process explored possibilities for re-appropriating and re-framing existing digital technologies as open toolkits, which can be further re-purposed by users, here and beyond, after the design of an initial toolkit prototype.

Keywords: digital tools; urban commoning; infrastructuring; co-design; analogue and digital prototyping

Introduction

This paper aims to open a discussion on the nature of participation in the design of digital technology used in processes of urban commoning. Rather than conceiving new technologies, our approach focuses on the uses for existing digital technologies, suggesting a potential path towards 'infrastructuring' (Hillgren, et al. 2011, Binder, et al. 2011) future re-appropriations of technology through assembling new digital tools by citizens involved in (mediated) commoning processes. Using the case study of an experimental civic hub located in a suburban neighbourhood near Paris, we test a co-design approach and subsequently put forward a set of co-design principles. These principles are intended as a way of enabling future iterations in design and research, extending participation in the design of digital tools for urban commoning.

Thus, a new approach is proposed regarding the role of technology in the context of widening participation in urban planning and local governance. Participation is a necessary democratic mechanism that can enable people to get involved in the co-production, entrepreneurship and governance of urban commons (Petrescu, et al. 2016). Nevertheless, participation in urban planning has arguably become a buzzword (Cornwall 2007, Alejandro Leal 2007), which needs critical reframing (Blundell-Jones, et al. 2005). To achieve meaningful participation in the planning of their everyday environments, inhabitants need to be involved not only in all stages of spatial production but also in the politics that precede this production; in the decision making,

the conception and governance of space (Baibarac 2015, Horelli 2013). Participation in the production of urban commons includes all of these multiple dimensions (Petrescu, et al. 2016). Rather than taking place at specific moments of the planning process, it is a process that necessarily unfolds over time, being intrisinc to the development and management of these urban commons.

The different tools, methods and technologies that are used to enable the process of urban commoning equally need to be participative and co-produced. The discussion on the co-production of technologies for urban commoning emerged within the context of the 'urban commons' discourse, which has at its core contestations over important urban resources, such as, temporary vacant spaces but also software and internet infrastructure (Foster and Iaione 2016, Petcou and Petrescu 2015). While, traditionally, commons struggles focused on access to, and governance of, a common pool of physical natural resources, such as pastures, fishing waters and forests (Ostrom 1990, Linebaugh 2008), the urban commons include a broader array of resources, which require a defined community and a set of values, protocols and norms devised collectively for the everyday subsistence of the resources (Bollier 2014). These urban commons are sustained by continual processes of 'commoning' – a term that refers to the social processes that create and reproduce the commons (Linebaugh 2008), which require community governance of common pool resources (Ostrom 1990).

The concept of 'commons' is also found in software development, specifically in the open-source, 'commons-based peer production' movement (Benkler 2006). Applying this open-source approach to urban space has been suggested to offer opportunities for achieving spatial commons that are designed collaboratively with the users, fulfilling needs and desires rather than producing profits, and also self-managed by them, rather than owned by private or public entities (Bradley 2015). For example, digital platforms such as 596 Acres[1] illustrate how technology can be used to nurture urban commons by providing spatial information and opportunities for connection between inhabitants (Radywyl and Biggs 2013). While such platforms can indeed sustain urban commons projects, little research has been done on how they could be co-designed in ways that can ensure the continuity of the commoning processes – and the further development of tools – beyond the initial designer(s) and a specific context.

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[1] http://596acres.org/
[2] http://r-urban.net/en/
[3] This was tested in the subsequent case studies by a research team member who did not have an

Widening participation in the production of technologies for urban commoning is important, particularly given that movements towards open-source, commons-based peer production are argued to represent the beginning of wider societal transformations (Benkler 2006), based, in principle, on open access to information and tools for innovation (Bollier 2014). The production of technologies, however, tends to require resources – often, money, time and know-how – which many communities may not have or find it difficult to access. At the same time, calls have been made for re-localizing both knowledge and the means for its co-production within the actual communities who will safeguard the commons (Antoniades and Apostol 2014).

This paper addresses the research need that emerges in this context: to design technologies intended to sustain urban commoning processes by involving their future users and also enabling them, and others, to create subsequent iterations in ways that are not resource-intensive. This is done by discussing an experimental co-design approach for the development of a toolkit for a commoning project and the resulting co-design framework, which can be used as a way of *infrastructuring* future developments of digital tools. 'Infrastructuring' refers to the creation of under-defined structures that can be continuously restructured during the use of technology in order to support emerging activities (Binder et al.2011).

The co-design approach discussed here is also directly related to issues of governance of urban commons. In 1990, Ostrom famously suggested a number of design principles for the institutions managing commons such as forests or fisheries (Ostrom 1990). These included:

1. The resource has clearly defined boundaries
2. Use and provision of resources are adapted to local conditions.
3. Rules and decisions are made through collective choice
4. There exist external recognition of the right to self-governed the resource
5. Violation of community rules are sanctioned
6. Conflicts are resolved through low cost conflict resolution mechanisms
7. The right of resource users to self-govern is recognized by higher level authorities
8. Rules are organised and enforced through multiple layers of nested enterprises.

More recently, Foster and Iaione (2017) suggested revisiting Ostrom's design principles in the context of urban commons, which are indeed more complex than the commons studied by Ostrom. Urban commons, are 'constructed commons', having a far more complex governance system involving not only commoners but also other urban

actors. They have retained only a number of these principles: they have recognized the important role of the *state as enabler* (corresponding to Ostrom's principle 7) and the idea of '*pooling economy'* which is locally adapted (Ostrom's principle 8 and 3) as well as the importance of *collective governance* (Ostrom's principle 3). They have also added the idea of '*experimentalism*', which acknowledge the presence of adaptive and iterative approaches to design processes and institutions related to urban commons and have underlined the important role of technology to enable collaborations and pooling. This principle of '*tech just'* underlines the importance of collaborative methods and open data protocols in the use of technology for urban commoning.

The toolkit and co-design framework discussed in this paper acknowledge these principles, addressing in particular aspects of collective governance, experimentalism and technological justice. The toolkit is intended to provide tools for better collective governance of local resilience practices and urban commons. It is 'experimental', being constructed through iterative processes and approaches to design, encouraging experimentalism further with the communities involved in constructing urban commons. It is also meant to be accessible to diverse users, aiming to contribute to technological justice by providing an open digital infrastructure and a set of principles for co-designing tools that can foster collaboration in the management of urban commons.

The paper commences by introducing the initial case study that led to the development of this first toolkit and also the co-design framework. This is followed by a discussion of the application of this co-design framework in two other urban contexts and in relation to different commoning projects as a way of illustrating the potential for infrastructuring.

Co-designing digital tools for (mediated) urban commons

The initial case study for the co-design of digital tools for urban commmoning is represented by a civic hub, located in an area with relatively high levels of socio-economic deprivation, in the northern Paris suburb of Colombes. This hub was deliberately selected for its specific characteristics in terms of urban commons (*mediated* commons, as discussed below) and type of 'users' (typically, with limited

resources, both monetary and know-how / expertise in relation to technology production).

The hub, Agrocité, is part of the R-Urban network[2] of civic hubs – an innovative project involving participative urban regeneration, based on resident-run facilities, which are intended to form local ecological cycles and to support everyday eco-civic practices. The project was initiated in 2011 by an architectural practice with which we have collaborated as part of this study, Atelier d'Architecture Autogérée (AAA), in partnership with Colombes Municipality (Petcou and Petrescu 2015, Petrescu, et al. 2016). The project was intended to create new forms of urban commons in a social housing estate, starting with Agrocité, which is an 'agricultural commons'.

Agrocité, as well as the other hubs built as initial prototypes of the R-Urban network, represent examples of *mediated* urban commons. They were not directly citizen-led in the first place; their emergence was enabled by the involvement of the AAA and was supported with external funding. AAA who are the initiators of the network have a mediating role in enabling the hub to become self-managed in time, this being part of a their long-term methodological approach (Petrescu, 2005). The have done this by using approaches such as, participatory governance, management training, social entrepreneurship and community economy advocacy. In addition, technology was also identified as a potentially useful mediating tool in the process of gradual transformation of the hubs into self-managed commons, which informed the selection of the case study.

The Agrocité hub comprises: an experimental micro-farm, community gardens, educational and cultural spaces, plus a range of experimental devices for compost-powered heating, rainwater collection, solar energy generation, aquaponic gardening and phyto-remediation. The hub is managed by a group of local residents who take charge of different activities and spaces, including: organising regular meetings; managing the cafe, the local shop and other collective facilities; maintaining the micro-farm and the community gardens; and coordinating the diverse activities of the hub. The management of the hub is done on a voluntary basis and therefore needs coordination among a group of volunteers, who are usually not present on site at the same time. The group meet periodically to address these various tasks, sometimes with support from AAA; however, many of the tasks need coordination on an everyday basis (gardening,

[2] http://r-urban.net/en/

chickens, cafe, etc.). This was used as an opportunity for co-designing a digital toolkit that could extend the existing organisational modes into the digital realm, which was seen as a useful way of addressing the challenges of coordinating activities across space and time – and therefore a real need of the hub (Baibarac and Petrescu, 2017).

In terms of 'users', Agrocité includes mostly retired and unemployed residents from a neighbouring social housing estate, with a majority of women, some of whom form the core group that manages the hub. Smartphone usage is relatively low within the group and Internet access to desktop or laptop devices is limited (although the hub has internet connection). Most of them lack familiarity with existing technologies, such as the social media platform Twitter (Facebook, for example, is more widely understood and used here). Importantly, the Agrocité project has no direct access to financial or infrastructural support for the development, implementation or ongoing management of digital technologies. In this sense, it represents a useful case for understanding what kinds of technologies would be useful for such commoning projects with few resources and also how they might be co-designed in ways that extend 'user' participation beyond the initial (and arguably, necessary) involvement of an 'expert'.

Thus, rather than focusing on the development of new software, the co-design process focused on exploring possibilities for (re)using and (re)assembling existing technologies to create 'situated digital platforms' (Langley 2017) (or toolkits) that can be customised to a specific context without the need for extensive or complex technical modifications. Prototyping was thus to be used as a method of co-design in order to develop a process that was both rapid and tangible for those involved, while creating opportunties for their direct involvement during the co-design moments and potentially beyond, in further adaptations and developments of toolkits. This was intended to offer opportunities for recursive (Teli, Bordin et al. 2015) and also to enable possiblities for the resilience of technology over time. The co-design approach used analogue and digital prototyping as a way of articulating and addressing the digital needs of the Agrocité hub and its users.

The Agrocité study led to a set of co-design principles, intended as a framework open to be reviewed, revised, re-interpreted and updated according to subsequent iterations and re-appropriations of technology for local commoning needs and without significant input from an 'expert'. This framework was subsequently applied in two other cases of urban commoning projects, which are described later in the paper.

Prototyping through analogue and digital making

The prototyping at Agrocité took place in June/July 2016 and involved a number of co-design workshops with a range of participants, including the research team, architects from AAA (practitioners mediating the contact with the hub users) and a number of local residents who usually had the task of running the hub. In addition, a technical adviser was also involved in the development of this initial toolkit – a computational designer with expertise in open-source platforms. This range of participants was retained also in the subsequent case studies but with progressively reduced support for the technical adviser, whose input in the last case study, in Bucharest, was minimal.

The co-design workshops were carried out as a progressive sequence, from initial discussions with the Agrocité group to better define the self-management needs of the hub (Figure 1; these included: calendar, recipe book, supplies, planting and harvest, and classes), to paper prototyping (Figure 2) and the definition of a prototype digital toolkit. Additional workshops were held as a series of knowledge-transfer sessions consisting of hands-on training on using the tools, aimed at facilitating the future use and expansion of the toolkit beyond the duration of the co-design study – an aspect of recursive engagement (Teli, Bordin et al. 2015).

The technical adviser led the workshops related to the digital prototyping of the toolkit. He proposed a number of existing technologies, such as Hotglue, Twitter, Team Up and Mirahaze Wiki, which he considered that could serve the needs identified with the Agrocité group, addressing the categories of tools defined during the paper prototyping (Table 1). This was held as a hands-on workshop, in which the technical adviser first showed how the selected technologies worked and then the participants could try them in relation to their specific needs (e.g., to record a recipe or to add a calendar entry). Following the workshop, a number of the tools were selected together with the participants who preferred technologies that had some similarities to those that they already knew (e.g., Twitter, which one participant had been using to find recipes). These tools became part of the AgrocitéHub digital toolkit prototype (https://agrocitehub.hotglue.me/), which was subsequently discussed and tested (Figure 3).

It is important to note that one of the factors influencing the selected tools, which formed the toolkit, was the cost and IT infrastructure limitations of the Agrocité context. Subsequently, training sessions were organised with AAA and the Agrocité group, during which the group learnt how to use the tools and developed their own user

guides (Figure 4), so that in turn they could teach others, through peer-to-peer support and without the support of the ‘expert’ – here, the technical adviser.

Figure 1: defining hub needs with Agrocité users

Figure 2: paper prototyping and defining tools categories

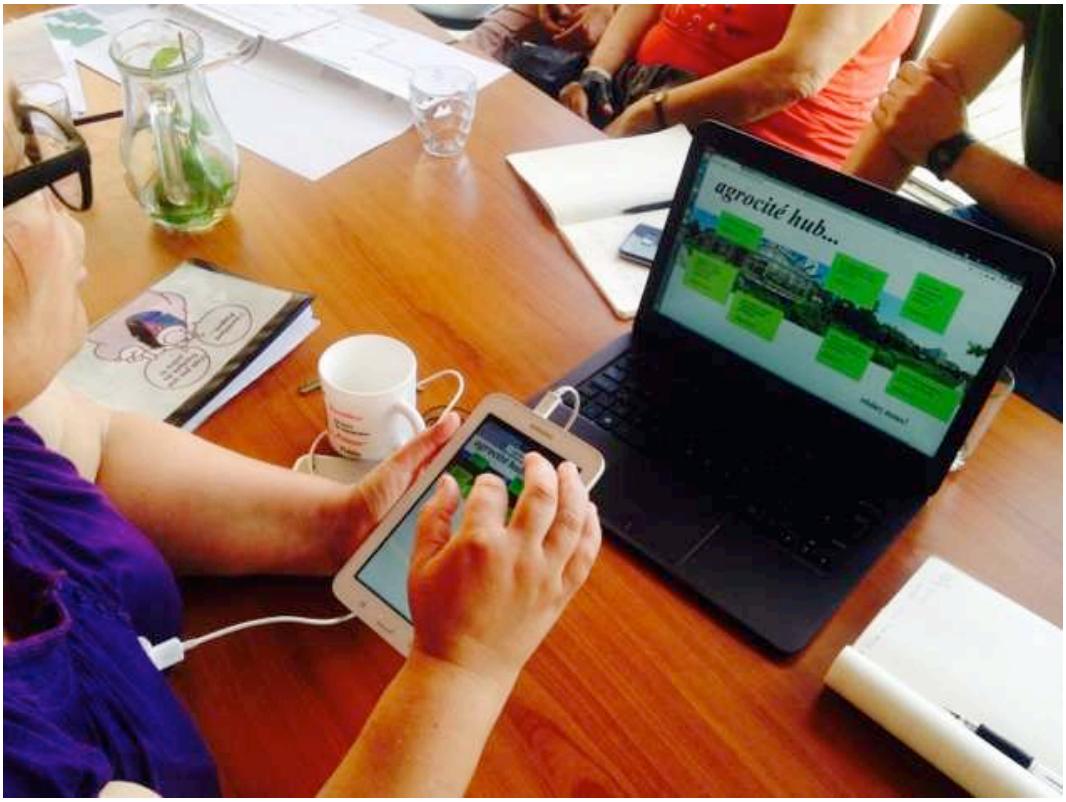

Figure 3: digital prototype

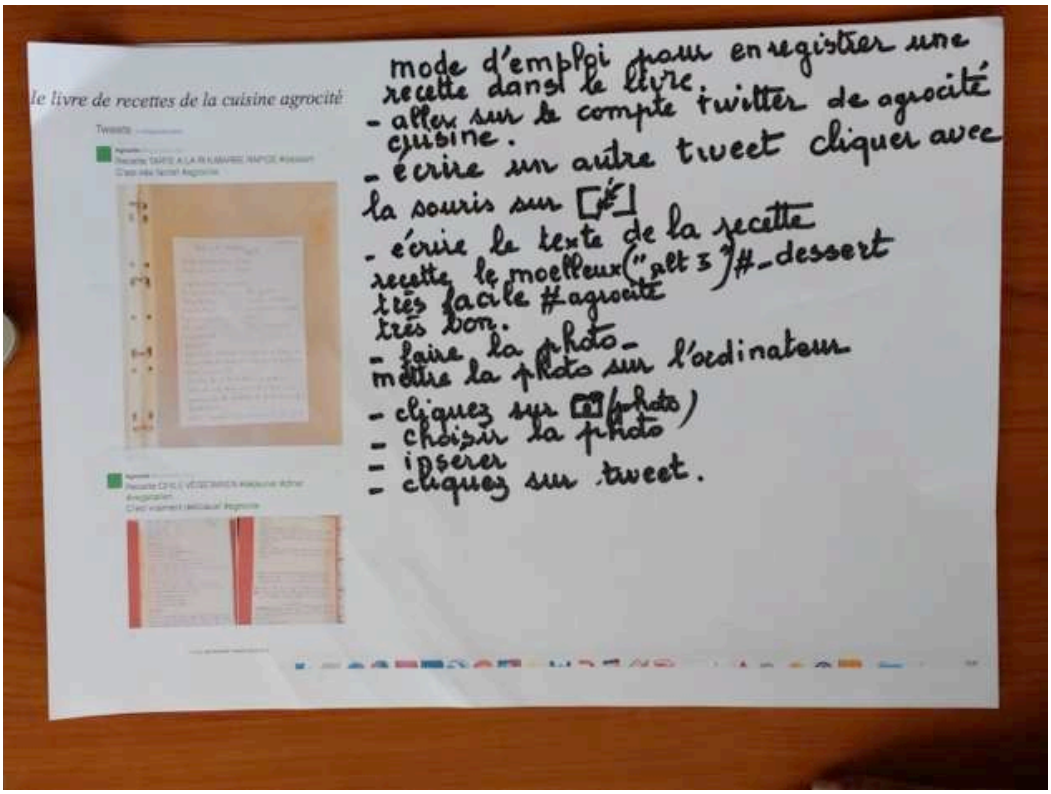

Figure 4: user-generated user guides

The toolkit prototype

AgrocitéHub toolkit

The sequencing of the prototyping processes highlighted the level of complexity and purpose for each tool. Ensuring that the tools were easy to use and served real needs was paramount. Moreover, the creation of analogue mock-ups was instrumental in articulating the needs of the hub with the Agrocité users and AAA. It allowed a de-construction of functionalities, which could be fulfilled by existing technologies, subsequently brought together into one coherent portal – the AgrocitéHub toolkit.

The AgrocitéHub toolkit (Figure 5) is a website that can be described as a portal into which converge a number of micro-tools tools addressing specific hub needs. The website was created using Hotglue (https://hotglue.me/), a visual website making and publishing open-source tool, which does not require any programming skills. The tools are made up of existing technologies, re-appropriated for specific purposes, such as internal organisation and management; and interaction with the community, similar hubs and networks (e.g., other R-Urban hubs, AMAP network and BioCoop chain of organic supermarkets). More specifically, the tools include: a recipe book (created using Twitter), a shared calendar (created using TeamUp), a resource map (created using Ushahidi), a planting and gardening guide (an interactive and editable 3D drawing of the collective garden), an instructions wiki around the use and maintenance of specific facilities such as the compost unit and the chicken coop (created using an ad-free wiki tool, Mirahaze) and a community page (the hub's existing Facebook group page) (Table 1).

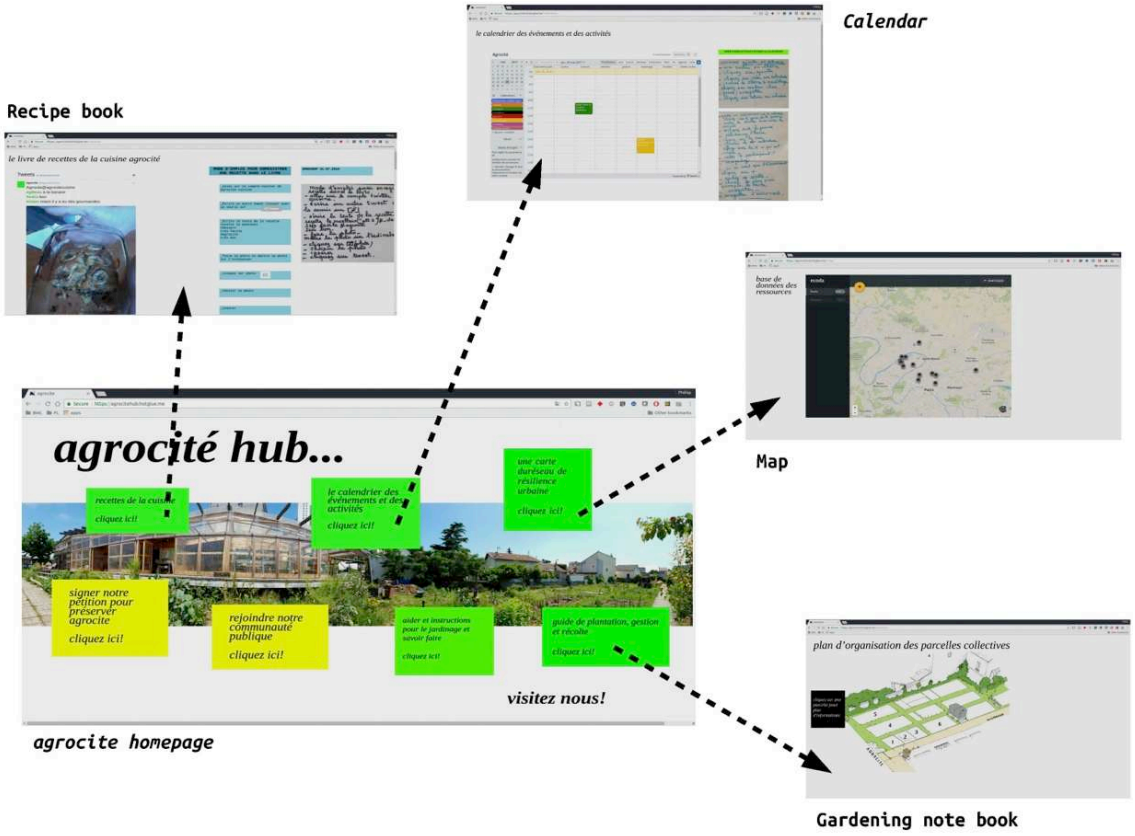

Figure 5: AgrocitéHub toolkit – illustration of components

The digital co-design framework

The Paris case study had an important role in the overall co-production process as it also led to the creation of a co-design framework, which was based upon reflection on the co-design process at Agrocité. We defined and used this co-design framework to guide the selection, deployment and assembly of all the other toolkit prototypes that followed. While developed in the case of, and with the participation of the group running Agrocité, the concept of micro-tools based on existing free technologies brought together into one coherent 'portal' (for example, using Hotglue as framework) – the AgrocitéHub model – could be imagined for other civic hubs, their local contexts and users. This model could be particularly useful for urban commoning projects (mediated by designers or initiated by local communities), which typically have minimal or no possibilities (e.g., financial, technical expertise) for developing digital technologies that specifically address their needs. While the approach does not fully remove the need for technical know-how, it does not require an 'expert' (e.g., software developer) as it uses existing technologies that may already be commonly used (e.g., Facebook, Twitter,

Google Maps) or are easily searchable and adapted to specific needs[3]. Indeed, following the three case studies, a collective online platform has been set up, which functions also as a database of potential technologies and ideas for how they could be used (https://ecodaplatform.hotglue.me/).

Thus, the Paris co-design process resulted not only in a digital output (the toolkit) but also in a set of digital co-design principles – a co-design framework – which can enable further co-production of knowledge in the design of digital tools for similar hubs by offering an open template. The co-design principles include: 1) recognizing that the functionality of software is co-produced (*sociality*); 2) using many software tools to build a digital prototype (*modularity*); 3) allowing for the instability of technology as a strategy for resilience (*instability*).

Sociality

Contained within the notion of modularity is that software is *social* (Mackenzie 2006) and that we must disassemble the binary relationship between software 'user' and software 'developer'. The functional operation of the software is not determined by an absolute 'capability' but is instead a negotiated 'capacity' that takes place between the software (and the agency and intentionality of the 'originator') and the 'recipient' (through their own capabilities) (ibid).

In the Agrocité co-design process, the development of the digital toolkit involved multiple site visits of the hub, meetings and workshops with its potential users, in order to better understand the needs that the technologies would need to address. This interaction, between the technical adviser (the 'originator'), the researchers, the AAA architects and the Agrocité users (the 'recipients'), was essential. It enabled the future users of the technology to communicate their needs for the management of hub, which are embedded in everyday practice and thus more difficult to articulate (Baibarac 2015) and at the same time, it allowed the research team and the technical adviser to identify and explore with the participants potential technologies that could be useful. This process of co-production between the various actors involved, which is relational and embedded in the local context, makes possible the development of relevant toolkits also for other hubs and their specifies.

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[3] This was tested in the subsequent case studies by a research team member who did not have an IT background or technoloogical training.

Modularity

Modularity is a well-established principle of software development, particularly in the open-source community. Through this approach, the functionality and performance of the operating system is delivered through an assembly of smaller software 'parts' that can then be managed and updated by a distributed group of contributors (Weber 2004). Furthermore, modularity is a concept in design for social innovation involving the production of semi-finished platforms rather than finite products, which can support and organize modular structures and systemic solutions, addressing local needs, yet capable of scaling (Morelli 2007).

The Agrocité Hub toolkit is essentially modular. Each tool within the kit is based on existing technology and fulfils a specific function. The tools distribute functionality in order to build resilience against changing circumstance, such as certain technologies becoming obsolete or disappearing in time, or changes in the hub's context and needs. Each module / function can easily be repaced by some other software, as necessary, without affecting the other modules or indeed overall toolkit. The tools are assembled – or centralized – through a common platform (here, Hotglue, https://hotglue.me) so that they may be accessed in a coordinated manner. This central platform also provides a degree of governance and control to the presentation (rather than operation) of the kit, which can also be applied to future toolkits.

Instability

'Stability', when referring to software, normally refers to its propensity for crashing – in this way, stability is good. However, discussions around 'Queer Technology' by artists such as Zach Blas contest this, questioning the very function of *functionality* and seeing a process of software 'destabilisation' as a positive step towards better understanding it (Blas 2013, Gaboury 2010).

The Agrocité Hub prototype, which offers an interrelated collection of functionalities and can be described as a modular assembly of tools, provides a framework of stability, within which the component parts (and indeed the infrastructural connections between them) remain inherently unstable. While each component is beyond the control of the users (as they are made up of existing technologies), the nature of the overall assembly is intended to provide resilience to such events. Non-

functioning ‘parts’ can be easily replaced (or upgraded) without disruption or disturbance to the overall framework.

Beyond this, the tension between the instability of the ‘part’ and the stability of the ‘assembly’ allows the toolkit to be customizable. Existing ‘parts’ may be replaced in accordance with the users’ practical need, without a drastic impact on the operation of the ‘assembly’. In this way, the upgrading (modification or expansion) of the prototype over time can be practically realised. This approach allows, in principle, for the current toolkit to act as a template that may easily be adapted in other locations and by other users, according to local needs.

Infrastructuring co-design

Following the prototyping of the initial toolkit in the northern Paris suburb of Colombes, the co-design principles were subsequently applied in two other European cities, London and Bucharest. These metropolitan contexts provide different cultural and political framings and traditions around the commons, and also various degrees of awareness and support for commoning projects. Similarly to the Paris case, the prototyping involved collaborations with local practitioners, typically architects who have initiated, or supported local communities in developing local commons for increased community resilience some of their local collaborators (for additional details refer to Baibarac and Petrescu, 2017)

In London, the prototyping took place between September-November 2016, in collaboration with the architectural practice Public Works and in relation to some of their project sites where they experiment with alternative economic practices through temporary uses of space (typically, unused public land or soon to be redeveloped) as a form of commons. The co-design process focused on tools for knowledge sharing across these sites – a key need as identified by Public Works and their community collaborators (Figure 6).

Following a similar co-design process as in the case of Agrocité, but with reduced involvement from the technical adviser this time, who only took part in an initial brainstorming workshop, the Resourcing Commons toolkit was prototyped (https://resourcingcommons.hotglue.me/). The co-design process involved a series of site visits, and workshops and discussions organised by the research team with architects from Public Works and site users, to better understand and define together the challenges faced by these alternative economic practices and opportunities for

strengthening them through knowledge-exchanges (Table 1). The prototype was built using the AgrocitéHub model: it uses the Hotglue as a framework or portal into which converge a number of existing technologies, adapted as tools for the specific needs of these communities.

Figure 6: London workshop

In Bucharest, the prototyping took place between February-March 2017, in collaboration with the architectural practice studioBasar whose work is focused on the civic activation of public space through temporary civic / cultural interventions. The co-design process focused on defining digital tools for sustaining knowledge-exchange processes across a network of local institutions (here, public libraries involved in collaborative initiative with studioBasar) and opening them up towards the surrounding communities as key needs for strengthening urban commons.

Similar to the Paris case, but this time without the involvement of the technology expert, co-design workshops were organised by the research team with architects from studioBasar as a progressive sequence of initial discussions, scenario making and paper prototyping. These sessions supported the librarians in defining a digital toolkit that could serve their specific needs, which included: professional development; partnerships and collaboration with local communities and civic organisations; communication and dialogue with existing and potential library users

(Table 1). The co-design process led to a digital prototype, BiblioLab (https://bibliolab.hotglue.me/), created following the initial AgrocitéHub model. Inspired by the Paris case, training sessions were subsequently organised by the participating librarians with colleagues as a way of encouraging the use of the toolkit beyond the initial study and group of users.

Figure 7: Bucharest workshop

Thus, the Bucharest workshops highlighted that peer-to-peer learning could benefit the re-appropriation of existing technologies within a group, particularly among users with relatively low levels of technical skill (or confidence in using technology). Working groups, or 'communities of practice' (Wenger 1998), could be useful in order to diffuse different tools comprised within a toolkit – something also noticed in the case of Agrocité. This could be achieved by creating groups interested in specific tools that become 'experts' in those tools and diffuse them further, through peer-to-peer learning. Moreover, as observed by one participant at the end of the workshops, peer-to-peer learning, together with the rapid prototyping of toolkits as modular assemblies of exiting free technologies, could enhance confidence in, and ownership of, digital technology even among users with an initial low level of technical knowledge.

While more work on additional applications of the co-design framework is needed, the three case studies discussed here highlight opportunities for

insfrastructuring co-design of digital tools for urban commoing projects using the co-design framework that emerged from the Agrocité co-design process. The co-design framework can continue to sustain the evolution of toolkits through everyday use and diffusion of knowledge among a group of users; and at the same time, make the co-design process replicable by offering an open template for other hubs involved in urban commons, thus enabling generativity (Schoffelen and Huybrechts 2013). By making visible the relational principles behind the 'design' of technology – or the selection and assembly of relevant existing software – the co-design framework can transform the agency of users (and initial participants in a co-design process), offering them the possibility to become co-creators.

The agency of software is thus seen here as relational – it is capable of 'intra-action' (Barad 2007) with other actors and in alternative contexts (Kitchin and Dodge 2011, Mackenzie 2006) and producing 'phenomena' beyond (Barad 2007). Software is not stable and does do not possess its own discrete agency. Instead, its agency is something that is co-produced as part of a larger formation.

The three prototypes discused here are assembled in such a way that this condition of software agency is acknowledged and made apparent. The toolkits allow for distributed uses through modification and reassembly to suit changing needs and different contexts. By co-designing agency along with technology, the co-design process remains open to continue beyond the life of the project, within and beyond the digital world. Specifically, it tactically uses existing technologies and it re-appropriates them for local conditions, needs and capabilities, through rapid prototyping and 'nesting' re-appropriated parts into new hybrid technological assemblies that are both digital and analogue.

These toolkits that were co-designed in the three locations are hosted on a digital platform (https://ecodaplatform.hotglue.me/), which supports sharing and networking between the different commoning initiatives and invites further uses of the prototyped tools, as well as the co-creation of new tools.

Table 1: The co-design framework and the assembly of tools created in the three locations

	Needs	Paper prototype categories	Software components	Digital parts (Tools)	Digital assembly (Toolkit)
Paris	1. Digitizing analogue information easily and using hand-held devices	archiving	Twitter	active public archive of recipes	**AgrocitéHub**
	2. Planning and coordinating activities for each hub function by those managing these functions	organisation	TeamUp	task and event planning	
	3. Creating user guides for hub activities (e.g. composting)	education & training	Mirahaze wiki	instructions guide	
	4. Scheduling gardening tasks and providing information on plots in a simple visual way	education & training	Hotglue & analogue 3d drawing	planting, caring & harvesting guide	
	5. Interacting with the existing hub community and potential new users	communication	Facebook	community page	
	6. Creating a crowdsourced database of partnership resources for the hub	mapping	Ushahidi	map database of existing & potential partnerships	
London	1. Sharing project processes with other project initiators	visualising + sharing	Free Timeline	retrospective project mapping (actors, governance, management, land, finance)	**Resourcing Commons**
	2. Sharing project information through the direct experience of those involved in them	mapping + sharing	Zee Maps	mapping projects through geo-tagged stories	
	3. Identifying and exchanging resources across a network of projects and groups	mapping + resourcing	Ushahidi	map database of resources offered and needed	
Bucharest	1. Mapping information about projects carried out by the libraries	mapping + communication	Zee Maps	mapping project typologies	**BiblioLAB**
	2. Consulting library users about existing and desired library activities	public participation	Google Forms	public consultation	
	3. Sharing 'how to' information about library activities across a network of libraries	education & training + sharing	Instructables	user guides	
	4. Creating an online co-working space for a network of libraries	collaboration	Wikispaces Classroom	team work space	

The co-design framework is thus put forward as a way of *infrastructuring* future technological re-appropriations and adaptations (Binder, et al. 2011, Hillgren, et al. 2011, Teli, et al. 2015). This entails the creation of incomplete structures that can be continuously re-purposed and developed over extended time-frames, beyond the project time and by (future) users, as mediators and co-designers.

Discussion and Conclusions

The co-design process used analogue and digital prototyping as a way of investigating the research and design context, and for eliciting the users' needs. This has led to a digital toolkit prototype and a series of co-design principles – a framework for co-design of digital tools for (mediated) urban commoning, Specifically, it provided a framework for the re-appropriation of existing technologies for specific user needs and commoning contexts, the replication of the design process and the further development of tools beyond the involvement of the initial researchers. Participation is thus opened and expanded beyond the initial 'user base' and the location and timeframe of the project, being understood as an open and flexible process of co-production, shaped, but not fully defined, by an initial technological proposition.

Agrocité offered a fist case study for applying and testing a series of co-design principles. The toolkit in this case has been successfully used until the hub has been deconstructed and relocated on a new site (February 2018). The community built around the hub has changed, many users leaving and new users joining in. The hub management system is in the process of resetting, so the toolkit needs to be adapted to the new conditions. This is a good chance for the process to be tested in a different context. The only tool that continues to be used without need of resting is the calendar tool because it is directly connected to the hub manager computer. The other tools need revisiting and collective re-appropriation by the new community. AAA currently mediates this process.

The co-design manifesto shaped two other studies, involving participants from Bucharest and London, which resulted in further re-appropriations of existing technologies and the development of digital tools for the specific needs of the groups involved (e.g., bibliolab.hotglue.me, in the case of a network of local libraries in Bucharest; and resourcingcommons.hotglue.me, in the case of an urban commons project in London). While some of the prototype tools have been taken over by the participants (e.g., a tool allowing the recording of training courses by librarians for their

colleagues), others have not been used after the end of the study. However, the codesign process itself, and the approach to the development of toolkits using existing technologies and the Hotglue base have provided a source of inspiration for the participant groups and also others (e.g., the digital platform hosting the toolkits and examples of other tools will be used by a group of students at Sheffield University as part of their participatory design projects in the current academic year, 2018-2019).

The co-design framework supports the selection and deployment of technology, offering opportunities for the continuation of the co-design process over time. Assembling digital tools can thus become an ongoing, collective activity, rather than a singular moment of 'design', allowing the users to modify, replace or add new tools, according to their evolving needs. Importantly, the co-design process also offers opportunities for learning-through-making, enabling users with little technical knowledge initially to become more confident in, and take ownership, of using and reappropriating technologies.

While the toolkits instantiate aspects of local commoning practice, the co-design framework thus has a key role in generating participation beyond the project time, location and initial 'makers' (Schoffelen and Huybrechts 2013), multiplying agents and diversifying agencies (Petrescu 2012). The process of learning-through-making by creating their own user guides, or training peers in the use of different tools comprised by the toolkits, enhances the users' agency in the further production of the toolkit. It enables peer-to-peer learning, which recognizes that "the provision of information holds no guarantee for knowledge, let alone of understanding" (Ingold 2013, p.1). The codesign framework can therefore have additional impact on the users' agency by offering them the possibility of changing the very functionality of the toolkit and in this process, also changing roles from 'users' to 'creators'. Taken together, the toolkits, user guides and co-design framework, have the potential to generate 'socio-technological assemblages' (Deleuze and Guattari 1987) that can enable the users to create value according to their own needs and aspirations – an essential pre-condition in urban commoning processes.

Participation in this project acknowledges and works *with* the binary expert/non-expert or technical/non-technical, considering their qualities and relationships together. Yet, this is not seen as a static and thus unchangeable dichotomy, but rather one that is dynamic and open to change over time, according to local specificities, user needs and their own time constraints. Time pressures and time scarcity are typical challenges for

practitioners operating within an urban commons framework (Petrescu, et al. 2016) – the openness, which characterises the co-design process and the outputs, allows for agility, making them less vulnerable to disruption and thus able to evolve over time. This process also empowers the initial 'users' to become 'stakeholders' of a continuously evolving prototype.

The *incompleteness* of the initial technological proposition and the principle of tactically re-appropriating existing technologies, which are 'at hand' (de Certeau 1984) to local users, contribute to this agility. As opposed to a fully finished product, which typically requires regular upgrading or technical support from the providers, an incomplete platform remains open to be modified and adapted to local needs and levels of expertise. While it cannot fully elimitate the need for some technical know-how, this can be minimal and easily sourced within a community, among its various members who may be acquainted with different 'common' technologies (e.g., Facebook, Twitter, Google Maps). Furthermore, this incompleteness also allows for technologies that are not available or 'common' in certain contexts, or indeed that become obsolete in time, to be easily replaced according to the needs of those who use them.

Furthermore, while ensuring the *resilience* of technology, the modularity of the toolkit and the open co-design framework, which offer a modifiable and replicable template rather than a finite product, enable the open prototyping of further iterations over time, according to the users' time availability and local needs. This is an open process that empowers users to enter (and exit) the process according to their specific needs and conditions, while collectively contributing, over time, to a prototype for an alternative society through infrastructuring capabilities for distributed action.

Acknowledging the opportunities offered by such an open co-design framework, further applications and testing will be required to assess its full potential. While subsequent experiments have been carried out in London and Bucharest in relation to other types of practices (yet, similarly sharing the goal to expand the urban commons), the process remains open for future iterations in design and research. A number of key research questions are put forward: What forms of governance and types of platforms are needed in order to support the scaling of local commoning practices? What kinds of digital tools might enable scaling through trans-local processes of commoning? How might such tools be co-designed? Moreover, there is potential in exploring applications of this approach at different scales and in different locations, also outside Europe, where social, technological, economic and political conditions can highlight new facets of co-

design. By developing further research and design propositions that address these questions, such a process can continue to expand the initial co-design framework and digital toolkits towards an open platform that can continue to create new avenues for participation, over time.

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