PARTICIPATORY PROTOTYPING FOR FUTURE CITIES

PETER VAN WAART
CREATING 010, ROTTERDAM UNIVERSITY OF APPLIED SCIENCES, WIJNHAVEN 99-107, 3011 WN ROTTERDAM, THE NETHERLANDS
PETER.VAN.WAART@HR.NL

INGRID MULDER
FACULTY OF INDUSTRIAL DESIGN ENGINEERING, DELFT UNIVERSITY OF TECHNOLOGY, LANDBERGSTRAAT 15, 2628 CE DELFT, THE NETHERLANDS
I.J.MULDER@TUDELFT.NL

CEES DE BONT
SCHOOL OF DESIGN, THE HONG KONG POLYTECHNIC UNIVERSITY, V810, JOCKEY CLUB INNOVATION TOWER (CORE V), HUNG HOM, KOWLOON HONG KONG
CEES.DEBONT@POLYU.EDU.HK

ABSTRACT

Emerging pervasive technologies such as the Internet of Things and Open Data will have severe impact on the experience, interactions and wellbeing of citizens in future smart cities. Local governments are concerned how to engage and embed citizens in the process of smart city development because without them it is difficult for governments and industrial technology providers to understand what future city is desired. We explore how prototyping methods can be used in a multi-helix approach towards a participatory domain in which multiple stakeholders collaboratively envision a desired future smart city. We adopted the different qualities of generative sessions, hackathons and design jams in our method of participatory prototyping for smart cities. Results show that participants appreciate this setting for exploration, experimentation, and making, in diverse teams with members from industry, government, university, and citizens. We will discuss issues for improvement of participatory prototyping to make it more robust for use in urban development processes.

INTRODUCTION

The emergence of technological developments such as the Internet of Things (IoT) and Open Data make governments and corporations dream of future smart cities that are safe to live in, economically prosperous, and full of high-tech services for their citizens. It is however questioned by academics, critics, and public organisations, to what extent these future visions encompass the social aspects of cities. Will they also become sociable smart cities? Future Internet scenarios show that the innovation model of creation and consolidation of new monopolies is stronger than that of open ecosystems that foster grassroots digital social innovation and entrepreneurship (Bria, 2014). For sociable smart cities that embrace both community-driven innovation and technology-driven innovations, society needs to transform into a more participative domain where participatory innovation takes place (Mulder, 2014).

In order to reach this participatory domain we explored how to engage a quadruple helix of stakeholders (public servants, entrepreneurs, educators and students, researchers, as well as citizens) in participatory prototyping in which they collaboratively envision desired future cities (Brodersen, Dindler, & Iversen, 2008; Carayannis & Campbell, 2012).

In earlier work we argued that a multi-helix approach is vital for engaging city stakeholders in a shared process of knowledge production in smart city development (P. Van Waart, Mulder, & De Bont, submitted). Citizens insights are crucial for understanding future cities that are not only functional effective and efficient but also sociable and liveable etc. To become a sociable smart city that is of meaning to its citizens, a strong position for citizens in the design process is required to address people's values (van Waart & Mulder, 2014). Application of pervasive technologies in a city means that all people will, consciously or unconsciously, interact with technological systems. For consumer markets, a close collaboration between university, industry and government (as described in the tripe helix model) might be sufficient for product or service innovations (Etzkowitz & Leydesdorff, 2000). People, as consumers, can choose services and products that result from those innovations, out of free choice. In smart cities in contrast, people are less free to choose to interact with pervasive technologies in the urban context. To legitimate and justify urban innovation towards smart cities, the important role of citizens (civic society) should be acknowledged. Carayannis and Campbell (2012) describe how the triple helix can be extended with a fourth helix to a quadruple helix that acknowledges the important role of the (media base and culture based) public or civil society. With this fourth helix, knowledge of culture, values and life styles, multi-culturalism, creativity, and media, are brought into the process (Figure 1.). The fourth helix represents and warrants the humanity aspects in the smart city development process in the participatory domain.

Figure 1. Quadruple Helix in the Participatory Domain

In the next section, we reflect on literature on participatory prototyping, generative sessions, hackathons and design jams to illustrate certain qualities of those methods and approaches that are adopted and altered into our approach in order to apply participatory prototyping as a method in the process of smart city development.

RELATED WORK

PARTICIPATORY PROTOTYPING: PROTOTYPING IN CO-DESIGN

In co-design end-users are in a relative strong position, although it's not common practice yet to have all stakeholders equally represented in the design process. Co-design is in keeping with business efforts for co-creation, in which consumers are offered possibilities to co-create value propositions (Prahalad & Ramaswamy, 2004). The move from user-centered to co-design is the change in roles and activities of the researcher, designer and user: the roles of researcher and designer are merged and the passive role of the end-user became an active role of the user as expert of his experiences (E. B.-N. Sanders & Stappers, 2008; Visser, Stappers, Van der Lugt, & Sanders, 2005). Sanders et al. defined co-design as the combination of creativity of trained designers and people not trained in design in the design development process (E. B.-N. Sanders & Stappers, 2008). They expect that design teams will become more diverse and will consist of professionals from many stakeholders in the design process, for example in the field of planning and architecture (E. B.-N. Sanders & Stappers, 2008).

In the case of smart cities, different stakeholders share some mutual interests but also will have their particular needs and desires. In transition management literature on governing urban innovation processes, the role of creative actors is emphasised in certain phases of the transition process. Creative actors are expected to support different stakeholder groups in envisioning future states of urban areas through participatory research (Nevens, Frantzeskaki, Gorissen, & Loorbach, 2013). From out the Multi Layer Perspective on transitions small scale experiments on niche level are important to explore and experiment with new technologies to envision future possibilities, as an influence on the socio-technical regime in which transitions has to take place (Geels, 2002; Geels & Schot, 2007). The current study is an exploration of possibilities to involve quadruple-helix stakeholders in the idea generation phase of the design process of smart cities.

In participatory prototyping characteristics of participatory design and prototyping converge. Binder et al. describe that participatory design originated in a critique towards a design approach that ignores the voice of end-users and other stakeholders (Binder, Brandt, & Gregory, 2008). Sanders and Stappers describe the importance of participatory design in the early fuzzy front-end phase of the design process where idea generation takes place and also that participation at the moment of decision is gaining interest (E. B.-N. Sanders & Stappers, 2008). The role of prototyping in participatory design has already been described in the late eighties of the last century by Scandinavian design researchers and was traditionally considered as 'a collaborative identification of possible futures, rooted in

current practice but with the purpose of introducing change' (Brodersen et al., 2008). In recent literature, the finesses of prototyping in different stages of the design process is well described (Gill, Sanders, & Shim, 2011). Especially, the importance of 'making' in early stages of the design process became more clear as an activity for making 'sense of the future' in in which storytelling, discussion and demonstration of use by participants is often more important than the artefact itself (E. B.-N. Sanders & Stappers, 2014). In the context of developing smart cities, we expected participatory prototyping to be an appropriate approach in which a multi-helix of stakeholders can be involved during idea generation through making of prototypes.

PROTOTYPING IN PRACTICE

In this section, we describe in brief the qualities of three types of prototyping in practice: generative sessions, hackathons and Design Jams (see also Table 1).

Generative sessions

In the field of co-design, generative sessions are used in contextmapping and service design projects (E.-N. Sanders, 2000; Visser et al., 2005). These are mentioned as a designer-led participatory method (E. B.-N. Sanders & Stappers, 2008). Actors are often designers and end-users. The characteristics of context mapping are the sensitizing of participants, the in-depth understanding of motivations in the context of use of people and the making to get in conversation. In generative sessions however, the products made by participants are often not 'possible products' but often visualisations as inspiration for designers to inform their design process.

Hackathons

Hackathons may be seen as a type of co-design in which non-experts co-create a product with business owners. Originated in the field of software development, hackathons are about building working technical prototypes with software and data in a very short period of time (one or several days). Consequently, hackathons are technology driven, and the actors are business case owners seeking for business solutions or opportunities, and software developers. Business case owners profit from the intellectual resources of software developers and compensate them with prizes. This is a way of crowdsourcing (Howe, 2006). The prototypes are not just usable to inspire designers (as in co-design methods such as context mapping) but are often the first iteration of an application that can be developed further. The goal is to make a working prototype to 'prove' that an idea works: data is used or elaborated and handled by a software application that delivers some kind of value to the (imagined) end-user. Making is a core asset of hackathons. Software developers (coders) are the active participants who can make use of data provided by other stakeholders. They bring their own tools such as laptops and programming software. Hackathons are often organised as competitions and as networking events. In recent years, companies and public bodies got interested in (civic) hackathons as a means for gaining innovative concepts for business and societal issues (Briscoe & Mulligan, 2014; Johnson & Robinson, 2014).

Design Jams

Prototyping is also an important ingredient of service design jams. Originated as in-company meetings of companies, the concept is now best known from the field of service design, for example the Global Service Jam (Römer, Thallmaier, Hormes, Lawrence, & Habicht, 2011). A service jam brings together different participants as innovation community in a two or three-days event for prototyping service innovations. Actors are usually service design enthusiast designers and case owners what make these jams design driven. Getting in touch with people (target group) in the real world is often part of the 3-day programme.

Table 1. Overview of qualities of generative sessions, hackathons, and design jams.

	Generative sessions	Hacka-thons	Design Jams	Gov Jams
Duration	Separate sessions of few hours	12 – 48 hours	48 hours	48 hours
Stake-holders	Designers (for client) and end-users (client's customers)	Organisa-tions with business case/ challenge, Software developers	Organisati ons with business case/ challenge, Designers	Governme nts with societal case/ challenge, Designers
Partici-pants	Designers End-users	Software developers Companies	Designers Companies	Designers Public servants
Authority relation-ship	Design-led	Business-led	Design-led	Design-led
Goal	Informing designers	Technical concepts to explore future innovation	Know-ledge sharing, Exposing design thinking to business	Know-ledge sharing, Exposing design thinking to govern-ments
Results	Customer insight, context insights, Inspira-tional informa-tion	Business concepts, Technical prototypes (artefacts) for future product develop-ment	Service prototypes, inspiratio-nal informa-tion, learning effects	Service prototypes, inspiratio-nal informa-tion, learning effects

CONSTRUCTING A METHOD FOR PARTICIPATORY PROTOTYPING FOR SMART CITIES

We envisioned that engaging participants from the four helices in a joint activity without hierarchical relations resembles what ideally will happen in the urban participatory domain: stakeholders that want to overcome conflicts of interests by positively negotiating what the desirable future state of the city should be. For participatory prototyping for smart cities, the following qualities of the different approaches and methods are important:

- The insights in use context and user as expert of daily life experiences from generative sessions;
- The aspect of 'making prototypes in-a-day' that enables participants to express their envisioned future by making functional artefact as a means of research through from hackathons;
- The non-hierarchic team setting, and the attention for service design competencies of empathy, visualising, and envisioning, of design jams.

We notice that in the various approaches mentioned above, one stakeholder is more leading than the other(s). In co-creation and co-design end-users are represented but the company respectively the designer is in lead of the process. In hackathons, software developers (coders, designers) are in the lead of sessions but the company is leading in organising and scoping the goal of the hackathon, and end-users are absent. Design Jams and Gov Jams are nowadays often organised by enthusiastic design professionals that invite companies of governments to provide practical case to work on, and end-users are sometimes passively involved as target group.

We also notice that in generative sessions, hackathons and design jams there are differences in representation of quadruple stakeholders as active participants (Table 2.). With regard to the quadruple helix of university, government, industry and citizens, we'd like to make a distinction within the category of industry. Industry is an ambiguous term when business case owners (brand corporations) as well as small design agencies or independent designers (or coders, in case of hackathons) are part of the industry. We will refer to the first as 'companies' and the latter as 'design professionals' or 'coders'.

TOWARDS PARTICIPATORY PROTOTYPING FOR SMART CITIES

As a result from this review of co-design methods we concluded that a true quadruple helix participatory domain approach is not common in practice. To unravel the possibilities and difficulties of a quadruple helix approach we want to find answers to the following questions:

- How can we engage participants from the quadruple helix of stakeholders in participatory prototyping?
- How can we sustain the relations between these participants as social fabric for future development?

Table 2. Representation of four helices in co-design.

	CIVIC End-users/ custom-ers/ citizens	UNI-VERSI-TY Design resear-chers / design students	INDUS-TRY Design professio nals/ coders	INDUS-TRY Compa-nies/ business owners	GO-VERN-MENT Public ser-vants
Co-creation	x			x	
Co-design	x		x		
Hacka-thons			x	x	
Civic hacka-thons	x		x	x	x
Design Jams		x	x	x	
Gov Jams		x	x		x

In design research projects in the city of Rotterdam, we organised several events, educational projects and labs with participants from quadruple helix stakeholders in which our approach was defined by the requirements mentioned below. We focussed more on the process of participatory prototyping than the prototypes resulting from that process. We wanted to apply a method in which the citizen's position is strengthened as well as having all stakeholders collaborate in making things in a non-hierarchical setting. From that, the following requirements for an appropriate method were stated:

- Facilitate teams consisting of participants from the quadruple helix;
- Participants are of equal importance (no hierarchy, no leaders);
- Participants share and understand each other's needs, wishes, desires, and values (diversity);
- Participants come to a shared understanding of a 'desired future smart city' that acknowledges diversity amongst stakeholders;
- A team of participants makes a concrete artefact (product or service concept).

PARTICIPATORY PROTOTYPING EVENTS

We organised two events as exploratory studies of participatory prototyping for future cities: *Hackday*

Data of the Crowds and *Rotterdam Gov Jam*. The events were held in the context of the city of Rotterdam in The Netherlands where early engagements of a quadruple helix of stakeholders in open data have put the release of public sector information on the local agenda. Moreover, applying participatory prototyping has led to an open data policy embraced by the local municipality. In both of these participatory prototyping events we involved the quadruple helix of stakeholders: student, teachers and researchers (university), public servants (government), (interactive) design agencies (companies) and citizens (society). Participants were divided in heterogeneous teams of about five members and briefed for an assignment based on real societal issues that occur in the city of Rotterdam. We encouraged the teams to make a prototype that expresses their shared envisioned future city based on mutual empathy an in-depth understanding of each other's point of view and interests.

For the hackday, April 9th 2014, we as university invited design companies to which the university was already related for curriculum purposes, internships and as advisory board. In the end 17 participants from 4 companies were involved in the hackday. Public servants were not involved as active participants but three public bodies of the city of Rotterdam brought in a dataset to be used by participants. Students and lecturers of the university were internally invited to join. 14 students took up the challenge. The event was announce through a website, Twitter account and a Facebook-page, through which 2 citizens signed up for the event. See also table 3 for an overview of the participants per helix.

Figure 2. Hall with participants of Hackday Data of the Crowds 2014.

Participants were given the challenge to develop a 'Personal API'. Working together in teams, participants were given the assignment to combine on one hand data from a wearable or personal device which could be used in Rotterdam (such as Fitbit, Withings, Jawbone) with on the other hand (Rotterdam) Open Data, in order to provide potential users with an enhanced experience of the city. The assignment also specified that this exchange of personal data with open data and data from other users (the city's residents and visitors), should focus on human needs. The hackday started at 10 AM and ended at 7 PM with pitching he prototypes to a jury of experts. A Fitbit was granted as first prize to the winning team, and gift coupons as second and third prize.

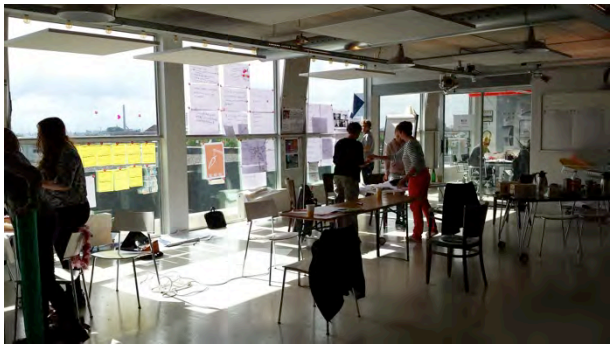

Figure 2. Event space with participants of Gov Jam 2014.

For the Gov Jam, lasting for 48 hours from June 3 to 5, one public servant was co-organiser by whom other public servants were engaged in scoping a societal issue into three cases for the jam. In that way 11 public servants joined the jam. Lecturers and students were internally invited and in the end 7 students and 3 lecturers participated in the jam. The Jam was communicated via a Facebook-page and Twitter account through which 16 design professionals signed up for the jam. See also table 3 for an overview of the participants per helix.

Table 3. Distribution of active participants over four helices of two participatory prototyping events.

	Hackday Data of the Crowds	Gov Jam
University (students/ lecturers)	14 (14/0)	10 (7/3)
Industry	17	16
Government	0	11
Citizens	2	0
Total	**33**	**37**

At the start, participants were invited to pitch a case they would like to work on, but in the end all participants chose to go along with the three prepared cases. The 48-hours programme consisted of several 'jams' (design sprints) that alternate with relaxing energizers, lunches and dinners. In the morning of the second day, participants visited people from the target groups of their case to get some insights. These insights were used to inform the design process. The final concepts were pitched to a jury of experts in the evening of the second day. At the third day, teams wrapped up their results an upload to the Gov Jam world server.

4 people from the organising team moderated the teams during the event.

PARTICIPATORY PROTOTYPING LAB SMART POPUP

During one school semester, September 2014 – February 2015, we established a lab, Smart Popup, in a neighbourhood in the city of Rotterdam, for 10 4th-year bachelor students who signed up for a minor course.

Figure 4. The Smart Pop-up lab in a local shopping street.

The building, a store in the local shopping street, was provided by the city of Rotterdam and two public servants were involved in the set-up of the lab. Both public servants were motivated by the idea that students might bring a creative impulse in this area of the city that is known for some severe societal issues (crime, safety, unemployment). Students were primed with theory on participatory design methods and coached to get inhabitants involved in their design of hybrid interactive media and technology installations that should support the needs and goals of people living in the area. Students formed several teams that worked on their own project. In the end, 2 citizens were involved in building a 3-D printer with students, 2 citizens were involved in daily practice in the lab, and one group of over 10 citizens were involved in one of the students projects (a sensor-based participation kit).

FINDINGS

We organised two events and a lab as an effort to engage participants from four helices to explore the collaboration of stakeholders in the participatory domain. At first sight, looking at the activities of participants at the two events, we conclude that participants from different stakeholder groups showed to collaborate in equality: No participant dominated by pushing his ideas or ideals to others. Participants discussed different perspectives on the issues at hand and collaboratively created concepts and prototypes to envision possible future urban interactions of people and technology. Especially the hackday, proved to be an appropriate set-up for making technically functional working prototypes with software and data. At the Gov Jam, results stayed at the level of service concepts.

Another positive result was the sustaining relationships of some of the participants who met each other for the first time during the event. Design professionals now work together with design students in design project in practice. Here we see some social fabric growing. The Gov Jam also provoked Rotterdam's city manager to declare on a videotaped interview that his servants should join creative professionals in jams like this, to cope with the wicked problems of urban society.

Nevertheless, engaging public servants was hard. For the Gov Jam, we put in much effort and preparation time with public servants before the event, to have them join the jam. In contrast, we didn't do that for the hackday, and no public servant was present as active participant at that event.

With regard to participants from industry, we succeeded to engage designers and coders from internet and design agencies. For the Gov Jam design professional were motivated to join for networking opportunities and to demonstrate their (service) design (thinking) skills. For the hackday, industry participants mentioned the possibility to experiment freely without restrictions of paying clients with new technologies and devices, to explore technical and commercial opportunities.

Engaging citizens as active participants was not an easy mission; only for the hackday two (technology minded) citizens showed up. For the Gov Jam, we contacted citizens belonging to the target group (unemployed people, people in the catering industry, and personnel from secondary schools) and agreed with them that the jam participants would consult them at a particular time and place. The Smart Popup Lab however was more successful in engaging citizens. The building was situated in the living context of citizens and therefore probably better accessible than the two events that took place at remote locations. Also the students encouraged passers-by to meet with them and to get to know people intentions in the neighbourhood. In the end, two citizens joined the student group as participant in creating installations with students.

DISCUSSION

In two events and one lab we deliberately tried to engage participants from a quadruple helix of stakeholders from the city of Rotterdam in the activity of participatory prototyping to envision a desirable smart city. Events and labs each have particular benefits and attract different participants from out different motivations. In our future work we intend to align events and labs (together with pilot projects, not mentioned in the current contribution) as a comprehensive palette of activities for exploring and experimenting with new technologies for supporting a participatory domain. Figure 5 illustrates how events and labs can be positioned in the process of urban transitions.

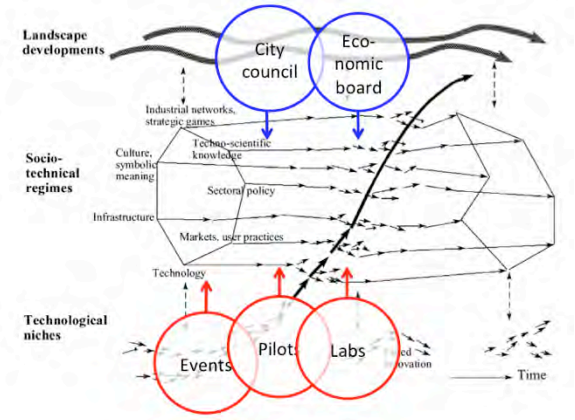

Figure 5. Positioning of participatory events, pilots and labs in the multilevel perspective of urban transitions. Source: Multi Level Perspective image derived from Geels (2002). Cirkels added by authors.

We perceive events as 'incidental' gatherings to get awareness amongst stakeholders and as opportunity to introduce new technology and concepts of future states of the (smart) city. We consider labs as a more sustainable activity at a physical location, situated in the area of interested of citizens who live there.

New questions that arise from our research activities are to what extent we can raise frequency of events and how we can sustain relations and activities amongst participants from the quadruple helix. Not the least, we are seeking for improvements to warrant people's culture and values in transitions of cities to future smart cities.

REFERENCES

Binder, T., Brandt, E., & Gregory, J. (2008). Design participation (-s).

Bria, F. (2014). Digital Social Innovation Interim report. London: Nesta.

Briscoe, G., & Mulligan, C. (2014). Digital Innovation: The Hackathon Phenomenon.

Brodersen, C., Dindler, C., & Iversen, O. S. (2008). Staging imaginative places for participatory prototyping. *Co-Design, 4*(1), 19-30.

Carayannis, E. G., & Campbell, D. F. (2012). *Mode 3 knowledge production in quadruple helix innovation systems*: Springer.

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research policy, 29*(2), 109-123.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research policy, 31*(8), 1257-1274.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research policy, 36*(3), 399-417.

Gill, C., Sanders, E., & Shim, S. (2011). *Prototypes as Inquiry, Visualization and Communication.* Paper presented at the DS 69: Proceedings of E&PDE 2011, the 13th International Conference on Engineering and Product Design Education, London, UK, 08.-09.09. 2011.

Howe, J. (2006). The rise of crowdsourcing. *Wired magazine, 14*(6), 1-4.

Johnson, P., & Robinson, P. (2014). Civic Hackathons: Innovation, Procurement, or Civic Engagement? *Review of Policy Research, 31*(4), 349-357.

Mulder, I. (2014). Sociable Smart Cities: Rethinking Our Future through Co-creative Partnerships *Distributed, Ambient, and Pervasive Interactions* (pp. 566-574): Springer

Nevens, F., Frantzeskaki, N., Gorissen, L., & Loorbach, D. (2013). Urban Transition Labs: co-creating transformative action for sustainable cities. *Journal of Cleaner Production, 50*, 111-122.

Prahalad, C. K., & Ramaswamy, V. (2004). Co-creation experiences: The next practice in value creation. *Journal of interactive marketing, 18*(3), 5-14.

Römer, M., Thallmaier, S., Hormes, M., Lawrence, A., & Habicht, H. (2011). *Jams as emerging practice of innovation communities: The case of the Global Service Jam.* Paper presented at the Conference Paper, Lecture Notes in Informatics LNI 192 Proceedings of the INFORMATIK 2011.

Sanders, E.-N. (2000). Generative tools for co-designing *Collaborative design* (pp. 3-12): Springer

Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *Co-design, 4*(1), 5-18.

Sanders, E. B.-N., & Stappers, P. J. (2014). Probes, toolkits and prototypes: three approaches to making in codesigning. *CoDesign, 10*(1), 5-14.

van Waart, P., & Mulder, I. (2014). Meaningful Interactions in a Smart City *Distributed, Ambient, and Pervasive Interactions* (pp. 617-628): Springer

Van Waart, P., Mulder, I. J., & De Bont, C. J. P. M. (submitted). A Participatory Approach for Envisioning a Smart City. *Manuscript under review*.

Visser, F. S., Stappers, P. J., Van der Lugt, R., & Sanders, E. B. (2005). Contextmapping: experiences from practice. *CoDesign, 1*(2), 119-149.