
Infrastructuring and the formation of publics in participatory design

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Abstract

Of late, there has been a renewed and reinvigorated exchange of ideas across science and technology studies and participatory design, emerging from a shared interest in ‘publics’. In this article, we explore the role of participatory design in constituting publics, drawing together recent scholarship in both science and technology studies and participatory design. To frame our discussion, we present two case studies of community-based participatory design as empirical examples. From these examples and the literature, we discuss the ways in which the concepts of *infrastructuring* and *attachments* are central to the constitution of publics. Finally, through an analysis of our case studies, we consider the differences between the practices of enabling participation and infrastructuring, calling attention to the ways that constituting publics foregrounds an engagement with authority structures and unknown futures through the participatory design process.

Keywords

design, design things, participation, publics

Introduction

Science and technology studies (STS) and design have long been intertwined; design researchers have drawn from STS discourses to frame their work (e.g. Ehn, 1990; Hirsch, 2008; Wilkie and Ward, 2008), and STS scholars have used design products and

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practices as the subjects of their inquiries (e.g. Latour and Weibel, 2005; Suchman, 2007; Winner, 1980). Recently, there has been a renewed and reinvigorated exchange of ideas across STS and participatory design (PD) emerging from a shared interest in ‘publics’. The notion of publics has proved to be especially salient with regard to discussions of the political qualities and potentials of PD, in that publics specifically address the ways in which participants endeavor to enact desired futures and prompt change (Björgvinsson et al., 2010; DiSalvo et al., 2008; Ehn, 2008; Galloway, in press; Le Dantec, 2012; Le Dantec et al., 2010, 2011; Marres, 2007; Wilkie and Michael, 2009). As PD increasingly moves from the workplace into community contexts, it is important to develop theoretical perspectives that can be used to better characterize the forms of social organization and action at play in communities and also to better characterize the practice of PD in relationship to these forms.

Our goal in this article is to further explore and elucidate some of the ways that publics form around and through PD. This inquiry is grounded in two recent community-based PD projects. Although the projects are generally similar in their community-focused participatory methods, they differ in significant respects. As we will discuss in further detail throughout this article, the first project was based on the construction of a technological intervention designed by, and deployed to support, social workers and their clients, while the second was framed as a project to increase the technological fluency of a community; the first took place in a setting with overt authority regimes, while the second encountered new authority dynamics through the design process; and the first tracked the formation of publics during and after a PD intervention, as the deployed technology remained in use long after the design work drew to a close, while the second project concluded when the PD workshops ended. These differences are useful because they allow us to examine the formation of publics in different stages of the PD process, from its initial stages through to its conclusion. This in turn allows us to question how different intended purposes of design might influence the constitution and actions of publics.

In the following, we discuss the notion of a public, tracing several definitions and identities through philosophy, STS, and PD. Our concern in this article is based on a particular interpretation of a public, one that draws upon the work of John Dewey (1954 [1927]). This article is further based on the socio-technical mechanisms for constituting and supporting a public, what we and others refer to as *infrastructuring* (Björgvinsson et al., 2010; Ehn, 2008; Le Dantec, 2012; Le Dantec et al., 2011; Star and Bowker, 2002). We then turn to the two projects as empirical examples of constituting publics in diverse and unique settings. Finally, we consider the role design discourse plays in motivating the kind of participation necessary to constitute a public, pointing out that PD provides appropriate methodological tools for directing the infrastructuring work needed to contend with future issues, rather than focusing solely on proximate concerns. We close by suggesting that a central component of infrastructuring toward a public is the process of identifying and forming attachments – the social and material dependencies and commitments of the people involved (Latour, 2004; Marres, 2007) – and noting that further empirical and theoretical work should be brought to bear on understanding attachments with more precision.

Publics, design, attachments, and infrastructuring

The term ‘the public’ has gone through numerous conceptual definitions and revisions. Habermas (1991 [1962]) proposed a foundational, if problematic, notion of the public, seeking to define it as a space in which the common good is taken up through rational discourse. Critiques of Habermas’ stance have moved the discussion of public spheres away from the supposition that the public can be thought as uniformly capable of participating in rationally derived consensus (Calhoun, 1993). As Fraser (1993) points out,

despite the rhetoric of publicity and accessibility, the [original Habermasian formulation of the] public sphere rested, indeed was importantly constituted by, a number of significant exclusions ... [A] key axis of exclusion [was] gender ... [where] a new, austere style of public speech and behavior was promoted, a style deemed ‘rational’, ‘virtuous’, and ‘manly’. (pp. 113–114)

The broader point that Fraser (1993) and those she cites make is that the early formulation of the public sphere rested on specific kinds of social relations, often those tied to ‘philanthropic, civic, professional, and cultural [societies that were] anything but accessible to everyone’ (p. 114). These exclusions are important because they led Fraser (1993), and later Warner (2005), to employ the notion of ‘counterpublics’ to make space for marginalized views and disenfranchised participants. While Fraser and Warner were working toward different ends, they shared a concern for recognizing diverse voices and pointing out that the boundaries of a public are far more permeable and uneven than the general, or universal, public originally set out by Habermas.

In our use of the word ‘public’, we embrace the contention, unevenness, and permeability of a public by recognizing that a public is usefully understood as a plurality of voices, opinions, and positions. Moreover, we contend that there is no single public, but rather a multitude of publics. In this, we return to John Dewey’s (1954 [1927]) book *The Public and Its Problems* and its pragmatist approach to defining a public, not as a single generic a priori mass of people, but as a particular configuration of individuals bound by common cause in confronting a shared issue.

As Dewey (1954 [1927]) states, ‘Those indirectly and seriously affected for good or for evil form a group distinctive enough to require recognition and a name. The name selected is The Public’ (p. 35). One noteworthy aspect of Dewey’s conception of a public, then, is that it is one of many unique federations of people who together are influenced or impressed upon by a specific set of conditions. As a public, these individuals seek to address these conditions and their consequences. These issues can either be of the present or the future; they can be experienced or anticipated conditions and consequences.

Dewey’s notion of a plurality of publics came as a response to Lippmann’s (1993 [1927]) *The Phantom Public*, in which Lippmann presents a view of political action by one disillusioned with participatory democracy, a view which stands in contrast to Dewey’s optimism. Where one sees the public as ineffectually meddling with experts, the other advocates more participation in civic action. Despite these divergent views, Dewey and Lippmann agree that a public is not a vehicle for the expression of popular will; as Marres (2007) points out in her discussion of the Lippman/Dewey debate, ‘publics form when issues require their involvement, and these publics are dedicated to ensuring that such issues are dealt with’ (p. 770).

While Dewey and Lippmann were concerned with publics as they related to statehood, it is useful to consider the formation of publics at scales that might only include particular communities. These communities might be physical, such as neighborhoods (DiSalvo and Lukens, 2009), or they might form around distant and mediated interactions (DiSalvo et al., 2008). Within this smaller, more intimate scale, the general principle that groups of people identify and express shared issues, and then organize and take action to achieve a desired result with respect to those issues, remains salient. Dewey's notion of publics provides a way to understand the conditions around which a public forms and to acknowledge that a public is not a vehicle of rationality and consensus, but rather, that it is a messy conglomeration of many stakeholders who might in other settings, around alternate issues, be at odds with each other.

Both in Dewey's (1954 [1927]) pragmatist view of participatory democracy and in the early movements that gave rise to the social phenomena around the Internet, we find a deep optimism about society's ability to overcome challenges through sharing ideas (i.e. identifying issues) and engaging with each other (i.e. mobilizing action) (Turner, 2006). It is this idea that has brought publics to the fore, as interest in social movements and political action has grown in contemporary design (e.g. DiSalvo et al., 2010; Hirsch et al., 2010; Lievrouw, 2006; Light et al., 2009; Saeed et al., 2009). The relevance of Dewey's perspective springs precisely from its tie to issues. It is the dynamic and contingent nature of a public, its fluid qualities as an entity, that allows a public to form and unform in concert with the evolving social conditions, and it is the manner in which diverse individuals are enlisted to contend with the effects of particular issues that make a public a useful perspective for design.

The relevance of publics to contemporary design and their connection to STS is made explicit by Bruno Latour. In the 2005 exhibition, *Making Things Public: Atmospheres of Democracy*, Latour and Peter Weibel curated a collection of diverse projects whose commonality lay in their attempt to articulate contemporary sociopolitical conditions and provide a means for the collective expression of and response to those conditions (Latour and Weibel, 2005). As Latour discusses in his curatorial essay, 'From Realpolitik to Dingpolitik – Or how to make things public' (Latour and Weibel, 2005), this effort was very much inspired by the work of Dewey, and we can take it to be one example of an inquiry into the relations between design and Deweyian publics. Key for Latour is the notion of an object-oriented democracy, or a democracy in which objects and things are acknowledged as playing a vital role. This notion is taken up in scholarship about techno-democracy and the novel opportunities that arise from using technology to broaden participation in democratic governance (Braun and Whatmore, 2010; Callon et al., 2009). Another key point for Latour is that publics are increasingly formed around future things: those objects or events that we reasonably believe will appear or occur but have yet to do so (Latour, 2007; Latour and Weibel, 2005). Genetically modified organisms (GMOs) are a case in point; long before any empirical data concerning these entities and their consequences had been collected, groups had formed in anticipation, to debate and act against their development and deployment. As a result, GMOs can be viewed as a future thing around which a public formed to confront the anticipated ecological, economic and even ethical consequences of GMO use in agriculture and food production (Dryzek, 2009).

In addition to Latour, others in STS have also pursued the confluence of design and publics. Marres (2007), in particular, turns a critical eye to the articulation of issues to do with publics, highlighting the conflict and contention that accompany the formation of any public. She makes the point that as publics come into being, they articulate issues with respect to the public's relation to the larger world, but do so with a new perspective that is contingent on the character of the formed public and not simply as a reframing of issues based on fixed points of view. Through this and other examples of STS scholarship (e.g. Dryzek, 2009; Hildebrandt and Gutwirth, 2008; Wilkie and Michael, 2009; Wilkie and Ward, 2008), we find an engagement with the question of how objects figure into the formation and expression of publics and their issues and how design processes and products might implicitly or explicitly participate in this endeavor.

Publics and attachments to issues

As Marres (2007) points out, 'Lippmann and Dewey ... moved away from the modernist idea that public involvement in politics is dedicated to expressing popular will. They proposed a shift in the purpose of public involvement from will formation to issue formation' (p. 769). This focus on issues is a critical piece in the relevance of publics to PD. In particular, it is the articulation of issues in publics, and the embrace of conflict and contention in the formation of a public, that differentiates publics from other concepts such as stakeholders.

Constituting a public is first an expression of issues, but this expression has a particular perspective and is informed by the makeup of the public and its relationship to the larger world. As a public mobilizes to address a set of issues, it implicates a set of relations in the world, some of which involve individuals, resources in a community, and objects. To further understand these implications, work in STS has taken up the question of how objects figure into the formation and expression of publics and their issues (Braun and Whatmore, 2010; Calhoun, 1993) and how design processes and products might implicitly or explicitly participate in this endeavor (Dryzek, 2009; Hildebrandt and Gutwirth, 2008; Wilkie and Michael, 2009; Wilkie and Ward, 2008).

These relationships can be described as 'attachments', a term that folds in the interplay of 'dependency on' and 'commitment to' that occurs as a public forms and enlists the resources of its multifarious membership (Marres, 2007). This view of attachments is meant as a distinction from the notion of 'frames':

The notion of frames stands out as an empirically useful concept to describe how public concern about issues is regulated by substantive means; that is, through issue definitions. ... Frames are usually characterized as relatively stable entities – established ideas, values, symbols or institutional devices – that are relied upon to set limits for unstable things. However, a distinctive feature of associations that are highlighted in public issue definitions is that they can no longer be taken for granted. (Marres, 2007: 774)

In relation to PD, increasing or supporting participation is, on its own, an act of framing in which the inclusion of different voices changes the scope of how solutions are formulated. Framing, however, is distanced from the issues themselves. Frames are a view *of*

existing issues, and frames can thus be taken for granted as a priori points of view. Therefore, frames, as Marres (2007: 774) points out, do not expose the tensions present in the dependencies and commitments of a public, because those dependencies and commitments are not a priori points of view. Rather, they are marshaled and modified by the constitution of the public. That is to say, a Deweyian public ‘comes into being as an effect of changing consequences of human action, which existing institutions can’t accommodate’ (Marres, 2007: 769). Attachments to issues, however, do provide a means of understanding the conflicts inherent in the constitution of publics, by recognizing the interplay and emergence of dependencies and commitments that form as a public forms; in other words, ‘by approaching issues as particular entanglements of actors’ attachments, it becomes possible to credit these entanglements as sources and resources for enacting of public involvement in controversy’ (Marres, 2007: 775).

The notion of attachments, then, foregrounds the dynamic relationships formed around issues and connects to the ongoing discourse about the role of PD as a means for engaging with power structures and marginalization (Balka, 2006; Beck, 2002; Shapiro, 2005). The important point to note here is that the constitution of publics and the development of attachments seem to be just the kind of politically engaged positions advocated within PD; the formation of publics and attachments is a way to connect directly with issues and reinvigorate a politically engaged PD in order to contend with the fact that ‘forms of participation exist and presently thrive that do not question, but further, dominant power patterns’ (Beck, 2002: 82). Where one might argue that frames reinforce these entrenched authority structures, the notion of attachments and publics enables us to move beyond a response to known relations in existing authoritative structures, toward a means of understanding and expressing those same authority structures as dynamic. Furthermore, the concept of publics provides PD with a pragmatic perspective for engaging community settings where the participants and the authority dynamics arise from complex and fluid social alignments rather than institutionalized divisions between, for example, management and labor (see DiSalvo et al., 2013).

Publics and the work of infrastructuring

Taken together, concepts of publics and attachments can provide scaffolding for understanding forms of civic action that center on marshaling diverse resources to confront particular issues. To accomplish this confrontation, however, there is additional work that takes place in the interplay between the social and material (or technical) structures that form.

In the studies by Ehn (2008) and Björgvinsson et al. (2010), we begin to see a turn in how PD attempts to situate itself within a broader community context. Rather than approaching PD as an orientation to product design focused on responding to present conditions, Ehn develops the argument that PD is more appropriately understood as *future* design, a process he terms, borrowing from Star and Ruhleder (1996) and Star and Bowker (2002), ‘infrastructuring’:

Hence, there will be a shift in focus from design-games aiming at useful products and services, to design-games to create good environments for design-games at use time. Typically this will

at project time lead to an occupation with identifying, designing and supporting social, technical and spatial infrastructures that are configurable and potentially supportive of future design-games in everyday use. (Ehn, 2008: 96)

The idea of infrastructuring through design employs the distinction between PD concerned primarily with design-for-use, centered on useful systems, and PD focused on design-for-future-use, structured to create fertile ground to sustain a community of participants. This entails a shift from treating designed systems as fixed products to treating them as ongoing infrastructure, socio-technical processes that relate different contexts (Star and Ruhleder, 1996). Infrastructuring, then, is the work of creating socio-technical resources that intentionally enable adoption and appropriation beyond the initial scope of the design, a process that might include participants not present during the initial design. In the words of Björgvinsson et al. (2010: 43):

Infrastructuring can be seen as an ongoing process and should not be seen as being delimited to a design project phase in the development of a free-standing system. Infrastructuring entangles and intertwines potentially controversial ‘*a priori* infrastructure activities’ (like selection, design, development, deployment, and enactment), with ‘everyday design activities in actual use’ (like mediation, interpretation and articulation), as well as ‘design in use’ (like adaptation, appropriation, tailoring, re-design and maintenance). (Karasti and Baker, 2008; Pipek and Wulf, 2009; Twidale and Floyd, 2008).

Part of the distinction between PD for useful systems and PD as infrastructuring comes by broadening the view of what counts as innovation, moving away from a technocratic view of innovation toward one that includes social innovation: innovation that arises out of social interactions and action that arises from the constitution of a public (Björgvinsson et al., 2010). Another aspect of the distinction between PD for useful systems and PD as infrastructuring is expressed as the difference between federating individuals in the discovery of unknown issues (in the case of infrastructuring), and a multi-stakeholder response to known issues (in the case of PD for useful systems). This position harkens back to the dichotomy between frames and attachments discussed above. Frames are largely about working around known issues, and attachments are about responding to evolving commitments and dependencies.

These notions of publics, attachments, and infrastructuring can be further unpacked and investigated empirically in order to elucidate how they relate to one another in practice and as a means for describing and analyzing community-based PD endeavors. To do so, we use two recent community-based PD projects as examples. Through our discussion of these projects, we will build a bridge between Ehn’s (2008) work, which connects infrastructuring and publics, and Marres’ (2007) work, which discusses the role of attachments in constituting publics. Drawing together these theories and the empirical examples, our claim is as follows: infrastructuring is a particular mode or practice of PD that develops and provides socio-material resources and experiences by way of attachments toward the constitution of publics. Although infrastructuring has been addressed in the PD literature, this interweaving of infrastructure, publics, and attachments presents a new perspective on the purposes and outcomes of PD practices. It returns a focus to the political aspects of PD, while also reconsidering the political conditions of community-based

PD. Rather than placing an emphasis on product or service development, this approach brings capacity building and associative politics to the fore.

Project I: community resource map

In 2007, one of the authors began to explore the impacts of information technology on a local urban homeless population and the organizations that provide basic services to them (Le Dantec, 2012; Le Dantec and Edwards, 2008a, 2008b, 2010; Le Dantec et al., 2010, 2011). The work looked at how information technologies – from mobile phones, to laptops, to internet-enabled social programs – were transforming life for the urban homeless. It did this by examining the role these technologies played in mundane daily life and work practices with a number of different stakeholders within the homeless community: a diverse cross section of the urban homeless (including single unemployed men and women living on the street, the working poor, and the homeless single-parent families); care providers and community organizations addressing a variety of different needs; and finally, government agencies that oversee health and human services programming across the state.

While the initial focus was to understand how existing practices around information technology affected the homeless, as the project matured, the main point of interest shifted to engaging a segment of the local homeless population in developing technology to address the practical challenges of sharing information, managing interactions with caseworkers, and building relationships between caseworkers and the homeless (Le Dantec and Edwards, 2008a, 2008b, 2010). The project centered on designing mobile-enabled information services to aggregate and distribute information about community resources. The design and deployment of the technology intervention, called the Community Resource Messenger (CRM), was located at a local emergency shelter for single-mother families. Given the context, the resources captured and presented by the system focused on employment opportunities, programs, and locations where these families could find permanent housing, information about schools and childcare, and general information about health care and local community news. Much of the information added to the system came from caseworkers, staff, and volunteers at the shelter; however, in addition to these institutional resources, the system included informal resources shared by shelter residents. This sharing of knowledge and expertise by and between homeless single-parent families became an important aspect of the project and is discussed in detail in the following (Le Dantec et al., 2010, 2011).

Configuring the participants

The design process used to develop the CRM came in two interwoven phases. First, we began by hosting a day-long workshop with a diverse set of care providers to understand the breadth of resources available in the community. The aim of the workshop was to discuss three key elements that would further inform system design: the resources available at each organization, the goals those resources were meant to meet, and the information needed in order for those resources to be effectively distributed. We combined the materials generated by the workshop participants in each of these categories to generate a

kind of map showing the specific points of interest (resources and goals) and the different paths between them (via the flow of information, procedural connections, and the geographic relationships between providers).

The outcomes of the workshop led us to focus on a single shelter that was centrally located on our conceptual map; it had connections to all the other providers and represented an entry into ‘the system’, as it provided aid to newly or episodically homeless single mothers and their children. At this point, we began the second phase of the project and focused in greater detail on the work done at the emergency shelter that we selected as our primary research site. We worked closely with the staff and residents at the shelter over a 4-month period to turn the conceptual map developed in the workshops into a mobile information system that would incorporate the types and sources of information the staff and residents desired (Le Dantec et al., 2010).

We began our design process by working with the staff to develop an information architecture for the resources they needed to share with the residents. We then presented these design ideas to the residents and asked them to respond to the designs, suggesting new or different features that would reflect their priorities. By alternating design sessions between staff and residents, we developed features that supported each group individually, as well as features that mediated information between the staff and residents. Importantly, our design process created a series of opportunities for the residents to begin thinking about their relationships to each other and to staff and to the information they needed to regain some measure of self-sufficiency. This process was the beginning of the residents coalescing into a distinct public, as they worked through their current needs and began to work through problems that future residents might encounter, discussing how they might create a system that could address those future issues as well. The resulting design reflected the process in that it intermixed sources of information from both publics so that information from staff and residents was made equally visible at the kiosk installed at the shelter’s entrance; information from the residents was displayed with as much prominence as information from the staff. Once the system was built and installed in the shelter, we continued to meet with the staff and residents over two set periods, one lasting 30 weeks and a second lasting 16 weeks. This second period occurred after making targeted changes to the system in response to feedback from the staff and residents (Le Dantec et al., 2011).

Emerging contention and conflict

During the system deployment, several dynamics emerged around the use of the CRM that are relevant to and indicative of the formation of publics. The initial fieldwork we conducted at the shelter suggested to us that there were multiple publics present and at work. We therefore approached the PD with a view toward engaging and distinguishing between two of those publics: shelter staff and shelter residents (Le Dantec et al., 2010). Membership in the second public was in perpetual flux as families entered the shelter and shared short-term dependency on the location for basic human needs. We understood these publics to be distinct; the staff were dealing with particular shared issues around effectively managing constrained resources, maintaining regulatory compliance, and coordinating care with all residents in a manner that was consistent with the identity, and mission of the

shelter, while the residents did not initially have a shared identity despite the fact that each family coped with common issues such as needing employment, childcare, and, more generally, household stability. Both the staff and the residents were contending with the authority dynamics; the staff worked within an organizational structure that set boundaries for how and when they were in contact with the residents, while the residents were confronted with the authority dynamics within the shelter, as the staff set strict rules, established goals with the residents, and directed programs and access to resources to support those goals. These relationships to forms of authority, and the way in which they initially informed the adoption of the CRM, demonstrate the work of identifying attachments and infrastructuring that contributes to the constitution of publics.

For the shelter staff, the CRM presented several new challenges to how work was organized and distributed between the program director and case managers. The consequence of the accumulated changes initiated by the CRM project was a systemic shift in how information was shared by the staff and in which staff members initiated that sharing. Prior to the deployment of the CRM, information about external programs and services was almost exclusively provided by the program director to residents in one-on-one counseling sessions; after the deployment of the CRM, one of the case managers used the system to post similar information, and in doing so caused that information to reach a wider audience, either through messages posted to the kiosk at the shelter entrance or through messages sent directly to residents' phones (Le Dantec et al., 2011). By embracing the new technology, the case manager created a shift in authority whereby the program director was no longer the primary gatekeeper to information. This shift, instigated by the case manager's use of the CRM, exposed the attachments the staff had to issues around sharing information and effectively managing limited resources. It prompted the staff to renegotiate how they coordinated their activities and integrated their case management work with the technology. This was, in our view, the work of infrastructuring, where the staff, as a public, recognized that their attachment to issues of sharing information (how widely? to whom? when?) was changing as a result of an intervention that provided new capabilities. In other words, a new socio-material relationship had emerged. In reconfiguring their work practices, the staff engaged in infrastructuring as they re-assigned work (from the program director to the case manager) and encouraged new members of their public to make the most of the CRM capabilities (e.g. by enrolling volunteers to update certain kinds of information that would be sent to the residents).

While staff members reconfigured aspects of their work through the CRM, shelter residents had their own experience with the system. The residents had begun to form a public during the design of the CRM, but it was not until the technology was deployed and made 'real' that they began to interpret the system as something they could take ownership of by expressing their knowledge and experience. One way this occurred was by using the shared kiosk to express positions on day-to-day issues at the shelter. One example of this arose from some residents falling behind in their chores and a fellow resident posting an anonymous message to the kiosk reminding the women of their shared responsibilities to clean common areas of the shelter at the end of each day. Importantly, the resident who posted the message tied it to the shared identity of being a resident at the shelter. The message prompted a series of conversations that further supported the constitution of the public of residents by establishing a shared identity through a set of common issues. This

shift was significant, as it marked a move in which the residents not only took ownership of their experience with the technology, but also recognized their (temporary) shared identity and used that to self-organize in a new and constructive way. In our framing here, the residents articulated their attachments to common issues, a commonality that was catalyzed by their shared responsibilities as residents at the shelter, but which grew to include the way in which they requested and responded to information shared by the staff. This shift occurred in part because residents incorporated the CRM as a resource for communicating with each other and with the staff. This adoption demonstrates that the kind of infrastructuring work that forms a public is not strictly limited to designing-for-future-use, as Ehn (2008) argues, but can occur through the use of a technical resource in dealing with current issues.

These descriptions begin to reveal how the CRM constituted and mediated between two distinct publics. The shelter staff and residents each configured themselves around the technology differently, and each experienced the technology differently, yet both integrated the technology into the way they organized as a public. For the staff, this was realized through changes in the division of labor (i.e. who is providing what information in what way) and in the recruitment of volunteers, whose capacity for sharing information with residents was also expanded. For the residents, the CRM was not only a mechanism for the staff to provide information, but also a platform for the residents to express their experiences. Residents further realized that the platform provided them with an ability to catalyze a shared identity by publicly articulating the issues facing them while at the shelter. These interactions had specific meaning for each of the publics, affecting the way they each identified the opportunities and issues and their responses to these issues, and it was around the CRM technology that these publics changed (in the case of the staff) or emerged (in the case of the residents).

Project 2: community sensing

In contrast to the first project, in which two publics were configured around a shared system, the second project examined the way a single public's membership and capabilities evolved in response to an evolving awareness of a shared condition. In the winter of 2008, one of the authors was contacted by a community advocate (whom we will refer to as David) from Braddock, Pennsylvania, to discuss possibilities for collaborating on the development of a community information technology program. The program was called 'Community 2.0', and its agenda was broad. As conceived by David, it was both a technology literacy program for adults and an organizational structure for initiating and coordinating a series of technology-enabled communication services, the prime example being mobile phone alerts of community events. David was seeking a university partner to assist in securing access to technology, as well as help with program development. From the start, there was an acknowledged tension between the agendas of the university research team and those of the community advocate. Both were committed to developing community technology programs with an emphasis on technological literacy, but the technologies of concern and the program themes were divergent; David and his group were focused on the direct application of current and familiar technologies and communication services, while the university research team was focused on unfamiliar

technologies with less immediately discernible applications, specifically focusing on robotics and sensing, and seeking to understand how PD and informal learning might couple to develop community technological fluency. A compromise was proposed: the program would be designed to prompt participants to explore how sensing and robotics technology might be used in local communication services. This process of alignment set the stage for attachments to develop and a public to emerge by grounding learning and speculation in a local desire and set of conditions (DiSalvo et al., 2009).

Over the following 6 months, the university research team met regularly with David and other community leaders and representatives he invited to participate in the project. These meetings were primarily about building relationships and trust and coming to know and understand the community better. Through these meetings, several themes emerged that shaped the project and began to define a public. Specifically, community members were concerned by what they perceived as a lack of voice for the neighborhood and the inability of the neighborhood to assert self-determination in its future. This concern was not unfounded. The borough of Braddock suffers from a postindustrial collapse of the local economy and diminishing social services. Once a vibrant steel-producing community, Braddock is now home to a fraction of its former population, and with this change, the community has witnessed a drying up of local financial resources. Nonetheless, there is a vibrant core of community organizations that endeavor to improve the neighborhood. However, by their own admission, their efforts to foster and sustain change were hampered by a lack of resources and a lack of coherence and collaboration between community organizations, each of which focuses on quite different areas (e.g. public health, teen unemployment, documentation and preservation of cultural heritage, business development). Indeed, these community organizations often found themselves at cross-purposes. But when brought together to focus on the community itself as a whole, they began to coalesce. Though this might seem an obvious move from the outside, it was not at all obvious to those individuals and groups. As they came together through the program, an initial primary motivation for the project was to develop a common effort to bolster the identity of the neighborhood and increase the agency of the residents. It was around these broad goals and conditions, then, that a public began to form.

The PD aspects of the program began in the summer of 2008 and continued through the summer of 2009, with weekly 2-hour workshops held at the local library. On an average workshop evening, between 6 and 12 people attended, with a core of 6 participants attending almost every event. The participants came from myriad organizational backgrounds. They included leaders and members of community advocacy and development organizations, leaders and members of local church groups, a representative from a regional environmental health nonprofit, a representative from a regional environmental awareness and restoration nonprofit, the leader of the local business association and local business owner, and two to three regularly attending neighborhood residents not affiliated with any particular organization. In addition to these core participants, 'drop-in' participants at any given workshop included local youths, regional artists, and members of various small business, community, and environmental organizations from the region.

Several weeks into the workshop, it had been announced that one of the bridges in the neighborhood was to undergo substantial, extended repairs. This bridge joined two areas of the community represented by the participants. It also served as a major thoroughfare

through the neighborhood for commuters coming from the suburbs into Pittsburgh. The announcement of the bridge work sparked lively conversation in the workshop, primarily because it was anticipated to cause a significant amount of traffic, and consequently frustration, in the neighborhood.

As a group, we began to brainstorm about ways that the technologies we were exploring might be brought to bear on this situation. An early suggestion was that sensors might be used to monitor the environmental effects of the bridge work, work that included stripping old paint and repainting the bridge. As the brainstorm progressed, it was suggested that perhaps the sensors could monitor the traffic itself, noting when and where there was congestion. This then led to a consideration of how that sensed information might be used, the first suggestion being text alerts on mobile phones with rerouting instructions.

As the brainstorm continued, a participant noted that one effect of this congestion would be that more people would be driving through Braddock and that they would be driving through Braddock more slowly. 'Could we', he asked, 'use this as an opportunity to tell them something about this neighborhood, maybe even get them to stop in Braddock and do something, here?' This question (paraphrased) caught the attention of the participants and the researchers alike, and the brainstorm began to focus on what kinds of things (facts, stories, upcoming events) might be told to the travelers in cars and how these things might be tied into the fluctuations in traffic conditions. From this brainstorm emerged a specific concept that came in response to the particular local event: the group proposed blending sensing technologies and using them, with their desire for an information communication platform, to create a community radio program that would integrate and respond to real-time traffic conditions.

A coalescing and evolving public

The organizations and people involved with this project developed a coherent agenda in response to the impending bridge repairs and that community began to grow in new directions. The bridge repairs and, more specifically, the anticipated consequences of the bridge repairs, became the issues around which the public took shape. This is not to say that the concerns of neighborhood identity and agency disappeared. Rather, they cohered around and were channeled through the issue of the bridge repairs, the conditions and consequences of which provided a topic that allowed for the diversity of the organizations to be expressed. The bridge repairs raised issues related to business development, public health, transportation, and history and heritage; these then became themes around which the commitments of a plurality of individuals and groups were rallied. Put another way, these conditions and consequences became the set of attachments that effectively engaged the participants and motivated them to action. It is worth pointing out that this formation of a public exemplifies Latour's (2007; Latour and Weibel, 2005) notion of publics forming around *future* objects. At the time of the project, the real consequences of the bridge repairs were unknown to the participants and could only be speculated upon. Nonetheless, the anticipation of effects was enough to mobilize residents into a public that actively considered and preemptively responded to the impending situation.

Over the subsequent workshops, the idea of the sensor-based community radio program was further developed by one of the community teams. The research staff provided

microphones and used readily available sound recoding and mixing software to record stories, snippets of information, and example event announcements with the participants. Together with the researchers, participants arranged these audio clips into single tracks and explored options for broadcasting. Another team constructed a scale model of the neighborhood out of craft supplies for the purpose of marking out where the various sensors might be placed in relation to anticipated traffic flow. A third team focused directly on the necessary technology, which was further divided into sensing technology, broadcast technology, and radio program development technology.

As the concept developed, it became increasingly apparent that producing a sensor-based radio program was going to require additional technology, resources, and planning. Thus, the participants started to solicit outside expertise. For example, in order to sense traffic flow, sensor technologies other than those currently being used in the workshop would be necessary. In addition, broadcast content became an issue requiring direction and management. Not only was there a question of what was going to be broadcast, but there was also the question of where that content was going to come from. Finally, radio itself became an issue. In the United States, unless one is operating an extremely low-power transmitter, registration and compliance with regulation is required to broadcast. One cannot set up and transmit a radio broadcast unless one is willing to knowingly break the law with a pirate radio station. This encounter with the regulatory issues of radio broadcasting became a central aspect of the project and will be addressed later in this article.

The common solution to each of these practicalities of the community technology initiative was to reach out to others for assistance, thus building the network of relations and capabilities and of social and material resources needed to complete the project. Over the course of the following months, the project expanded to include individuals and local organizations with experience in radio programming and broadcasting, as well as designers and researchers with experience in systems development and integration. The effect of this, then, was to broaden both the groups of individuals and local organizations working together and the themes that kept the public simultaneously pluralistic and focused.

In contrast to the first project, this second one demonstrates how a single public emerged in the context of developing a technology-focused neighborhood intervention. As the group came to realize its capabilities and limitations (in technical skills, knowledge of municipal regulations, and radio content development), it reached out to external groups and individuals with expertise in these domains. Although this increased the heterogeneity of the group, it did not result in a splintering of this public. Indeed, as the group grew in size and diversity, the original set of community organizers and participants explicitly expressed a desire to maintain the group's identity and functioning as a coherent singular entity, as a group dedicated to addressing *this* problem in *this* manner.

Discussion

As we described above, in the sense in which we are using the term, a public is not a generic preexisting mass of people; it is a dynamic organization of individuals and groups formed by the desire to address an issue. Publics are developed through the

activity of exposing and articulating the conditions of an issue so that communal action can be taken to mitigate or amplify certain outcomes (Dewey, 1954 [1927]). Through this activity, multiple and diverse constituencies are bound together. As exemplified in both of the preceding projects, even though the practices of such constituencies might differ, they share an approach to the object or situation of concern and a set of desired outcomes. In the context of PD, the challenge is to develop a better understanding of *how* publics are formed, so that PD might contribute to that process (Björgvinsson et al., 2010; Ehn, 2008). This leads to the question of whether there is a common process or factor in the formation of publics. It is tempting to suggest that participation might be such a factor; however, we argue that *participation itself is insufficient to account for the formation of publics*.

The literature on public participation has many examples of technology systems designed to engage diverse stakeholders in process. For example, projects like UrbanSim have used participation mediated by technology to bring different voices into discourse over shared policy and urban development decisions (Borning et al., 2005; Friedman et al., 2008). Such efforts have certainly been effective and raised important questions within the research discourse about how to build large-scale participatory systems. However, it is projects like these that, one might argue, lead Ehn (2008) to make the distinction between PD for useful systems – that is, those that engage participation within a specific and finite domain – and PD as an act of infrastructuring.

The difference between PD for useful systems and PD as infrastructuring is subtle but important. It is perhaps best articulated as the difference between a multi-stakeholder *response* to known issues (in the case of PD for useful systems) and federating individuals in the *discovery* of unknown issues (in the case of infrastructuring). Where Callon et al. (2009) have largely focused on exploring known issues through their framing of ‘hybrid forums’, we would point to our work with PD both as a means of decomposing the black box of ‘discourse’ underpinning the notion of hybrid forums and as a specific methodological contribution to the broad interest in moving beyond basic participation toward more robust forms of inclusion (Braun and Whatmore, 2010; Callon et al., 2009). The distinctions between engaging in response and discovery, and between contexts of the known and the unknown, are significant enough for us to assert that enabling participation and constituting a public are two different, though related, things.

As we pointed out in the beginning of this article, there is a distinction between enabling participation and constituting publics, one that traces the difference between *framing* issues and developing *attachments* (Marres, 2007). We further suggest that constituting a public involves discovering and expressing the attachments of a particular group. Infrastructuring, as an activity of PD, is the work, then, of *providing the means* for discovering and expressing those attachments in order to convey the consequences of an issue and to enroll others in a cause. Moreover, an important aspect of infrastructuring is recognizing that those attachments are dynamic; they will change, often in unanticipated ways.

Infrastructuring as a response to entrenched authority

The infrastructuring work done in constituting publics demonstrates how PD can reveal power structures, especially in light of how the introduction and adoption of technology

innovation alters or amplifies such structures. In the second project, the group's confrontation with and response to the regulatory issues of radio broadcasting presents such an example of how infrastructuring can be deployed as a response to entrenched authority or other networks of control, expertise, or influence. As the group developed their idea for a community radio intervention, they soon encountered the legal limits of their possible actions. To legally construct and deploy a radio station required acquiring a license, which was financially beyond the resources of the group. The immediate response of the group was to call attention to this as yet another example of how their capacities for self-expression, and even self-determination, were thwarted by external forces beyond their control. Encountering the conditions of radio broadcasting thus revealed a previously unknown authoritative regulatory structure. Moreover, the PD endeavor produced a shared experience of that authoritative regulatory structure as a direct and real force that conflicted with the desires of the participants. To address this situation, the participants had to move beyond a simple critique of the condition. They had to invent systems to intervene in the situation in ways that would enable them to take the action they desired. This necessitated an explication of, and engagement with, these regulatory structures in order to design work-arounds.

In discussing options, one individual suggested that perhaps the group should consider embracing the concept of pirate radio and construct an illegal radio broadcast program. This suggestion generated an immediate and lively debate. The topic of concern was not the legal ramifications of operating a radio station outside of regulatory statutes but what consequence that might have on their original goals of 'taking charge' and 'amplifying the voice' of the community. The participants were not so much worried about fines they might incur from operating a pirate radio station, but rather they were concerned that embracing pirate radio might unproductively express a confrontational stance between the group and local municipal officials and organizations, whom they were ultimately reliant upon for financial, material, and social support. As a solution, the group decided to reach out to others to explore legal alternatives, such as shared airtime and low-power frequency modulation (FM), which would allow them to further develop their idea and retain their agenda without damaging their support base. Thus, echoing Marres's (2007) terms, through confronting the unanticipated authoritative structure of broadcast regulations, the group came to realize that in order to achieve their fundamental 'commitment to' the community, they would need to increase their 'dependency on' others.

The response of the design team to this situation provides an example of PD as infrastructuring. Rather than working toward implementing a particular technical solution, the design team worked with the group to develop means by which the group could communicate their desires and challenges to others in the hope of soliciting support and enrolling others in their public. This effort included working to improve participants' skills in developing compelling descriptions of their project through both narratives and physical artifacts. It also included orchestrating events that brought the participants together with relevant local community members whose expertise they needed (DiSalvo et al., 2009). In effect, as an infrastructuring project, the design team's goal was to help the group develop the socio-material resources that would allow *others* to develop attachments to *their* issue and agenda. More broadly, the objective of these activities can be understood as infrastructuring, then, because rather than providing, or even codesigning, a specific technical

solution, the design team worked to provide the group with the capacities to address the current obstacle, capacities that would hopefully be transferable to addressing future such obstacles as well.

Infrastructuring with a useful system

Contrary to what Ehn (2008) has suggested, the first project provides some evidence that PD around publics does not in fact need to make a choice between the design of a practical or useful system and design as infrastructuring. While design-for-future-use as infrastructuring and design-for-use as practical system design are different – one opens up questions and possibilities, while the other narrows possibilities through practical design moves – the two can complement each other and coexist as a means of expressing the attachments between publics. The first project provides an example of how a codesigned, practical system can also do the work of infrastructuring by exposing attachments in different ways and providing affordances in the technology for responding to and shaping those attachments.

In designing the CRM, much of the discussion was grounded in the everyday constraints of current work practices and information needs at the shelter, including the relationship between shelter staff and residents, the accountabilities and obligations of shelter staff within the regulatory context in the United States, the differentials in responsibility and institutional influence between staff and residents, and the need for communal support among the residents. These distinct arrangements shaped how both publics changed in relation to the design and narrowed the possible activities that might be mediated by the CRM, eventually focusing on forms of communication, kinds of information shared, and means of making visible different perspectives on shelter life.

However, through these practical issues, a discussion of the dependencies and commitments of both shelter staff and residents emerged. Some of these relationships were as one might expect; shelter staff were committed to helping the residents and to maintaining an environment of support and encouragement, yet the staff also depended on the residents to make efforts to find gainful employment, to successfully complete job training programs, and to enroll in counseling courses. Conversely, the residents depended on the shelter for basic needs and help connecting to external programs for employment support, childcare, and legal aid (among others). The residents' commitments included helping themselves get out of the shelter and maintaining private lives and a sense of self-respect and independence in the face of significant institutional dependence. The characteristics of these different dependencies and commitments exposed facets of the social dynamics in the shelter that were more nuanced than the gross cleavage between careprovider and client. Certainly, the staff members composed an authoritative structure, and the way that authority was wielded was under constant negotiation among the staff and between the staff and the residents. The PD and use of the CRM exposed these negotiations to the two publics by allowing different actors to influence the information and the discourse about available information through newly introduced channels of communication.

As the design matured, and the CRM went into use, a shift took place in how the two publics engaged with the system and with the ongoing design discourse. Instead

of focusing on the current practical needs, the interaction became about the future arrangements of staff and residents and the implication for how they would relate to each other. The dependency of the residents on the shelter staff started to be reconfigured via the CRM by putting information and exchanges from both staff and residents on equal footing, allowing both publics to take a measure of ownership of the technology and to appropriate its use and interpret its content independently.

Publics as infrastructuring PD

Attachments to issues delineate a public and create resources for action. Infrastructuring enables a public's members to identify and address issues in an ongoing manner, creating a socio-technical response that relates the current context of the public to the future context the public is trying to attain. Infrastructuring thus can be viewed as one of the key components to sustaining a public over time. Moreover, infrastructuring can and does occur around systems that were intended to be useful, and the development of the CRM is such an example.

Both projects presented in this article start to unpack some of the properties that contribute to the constitution of publics, though they do so from different angles and with different outcomes. The common element in both cases is that infrastructuring comes as a result of the reconfigurations that occur around and with a technological intervention; that is, the deployment of the technology is a beginning, not an end. It may serve as a catalyzing factor when constituting a public or it may be a factor that prompts a public to change its constitution, but in either case, the technological intervention is not to be understood as the culmination of a public's formation. For example, in the first project, the technical intervention of the CRM deployed to shelter staff and residents was constrained by the visibilities of different forms of communication. In spite of these constraints, the CRM had many degrees of freedom with respect to how users could reshape the technology for their own purposes. It was just this combination of different visibilities of information and the freedom to reconfigure responses to information that resulted in the shifting of social boundaries and strategies for expressing self-determination and personal empowerment within the shelter.

Ownership, in both cases, played an important role within the work of infrastructuring because of the way it oriented the participants toward engaging in design for future use. Arguably, PD has long been concerned with different aspects of ownership in the design and development of artifacts and systems (e.g. Balka, 2006; Carstensen et al., 1999; Davis, 2009; Luke et al., 2004; Merkel et al., 2004). This is particularly true in community-focused endeavors where ownership over the final product has been found to be critical for project sustainability (Carroll and Rosson, 2007; Merkel et al., 2004). However, as with the earlier distinction between response to known issues versus the discovery of new issues, the work of ownership in infrastructuring is not the ownership of the material product *itself* so much as the ownership of shaping future attachments by way of a *relationship to* the material product. In this way, in the first project, the staff and residents at the shelter had ownership of the intervention in that it was continually being reimagined and its use reconfigured around shifting social boundaries. Similarly, the participants in the second project owned their intervention, albeit more directly as designers of

the system, and through that ownership shifted their response to externalities first by developing strategies for coping with the anticipated impact of the bridge closure and then later by widening participation in their public to enhance expertise and skill in developing radio technologies.

By approaching and understanding PD interventions as contributing to the constitution of publics, these case studies begin to show how we might respond to some of the challenges of bringing PD to large-scale projects (Balka, 2006; Shapiro, 2005). One such challenge in developing large-scale participatory endeavors is the cost involved in what is usually perceived as a product design process. Yet one of the shortcomings in treating PD as product design is that the outcome is presumed to be materially fixed – a product – while the attachments between the different stakeholders are dynamic. Moreover, the introduction of new forms of technology amplifies and mutes that dynamism in different ways. The participation – and the ownership – of the design ends when the product is complete, and the fundamental benefits of involving stakeholders as codesigners rather than consumers are undermined (Sanders, 2005, 2006).

Attachments

Our analysis suggests that the concept of infrastructuring is useful for understanding the participatory process not as one that ends with a product, but instead as one that initiates or shapes publics. With this promising perspective come additional challenges to research at the intersection of PD and STS. Among these is the problem of further elucidating the concept of attachments and the relationship of attachments to emerging discourses in PD. Latour's (2004) discussion of contemporary political associations provides a useful starting point. As he points out, in some environmental debates, bizarre coalitions form between groups that would otherwise be adversaries. In such cases, attachments form and function on another register from that of the standard political left or right, capitalist or Marxist, and environmentalist or industrialist. Rather, attachments emerge from, and operate on, affective, ethical, and, in some cases, moral registers.

Marres (2007) provides further insights into the nature of attachments in her discussion of 'commitments to' and 'dependencies on', suggesting that attachments could be understood as the character of a relation between an individual or group and an object. To have a commitment obliges one to maintain that relation or the object of that relation. To have a dependency is to rely upon a relation or the object of the relation. These commitments and dependencies are, in effect, affective bonds between people and things, which are expressive of the conditions of an issue or the desired outcome of the issue. For example, in the second project, the prototype radio system became the object through which community members were able to enact their commitment to the neighborhood. Time, effort, and material resources were given to the radio program as a way of maintaining bonds with others who were also committed to the neighborhood. Through their attachments to the radio program, participants shared and collectively expressed a desire to bolster the identity of the neighborhood and to increase the agency of the residents. In a similar manner, the CRM can be understood as an object that fostered a productive dependency. Through design and use, the two publics of that project developed a communal reliance on the system. Iterations in the systems were, in fact, iterations in the configuration of the relations between the constituent members of each of the publics.

Another way to describe the infrastructuring work of PD, then, is as providing scaffolding for affective bonds that are necessary for the construction of publics. The activities of design described throughout the two projects worked to produce the objects that ultimately expressed the conditions of an issue or the desired outcome of the issue. That is, through PD, objects were created to which attachments could form. This is *not* to say that emotions, beliefs, or desires were shaped by design, but rather that design provided structures to which emotions, beliefs, and desires might adhere and thus be sustained.

Conclusion

As the scope of design increases, so too does the scope of PD. More and more, PD is being practiced in neighborhood centers, schools, museums, and with communities of interest. The methods and theories from PD in the workplace are still valuable in these contexts, but we also need new perspectives that take into account the different values and relations in these settings. Publics and infrastructuring, together, form a perspective on the changing practices and potentials of PD that highlight the messy, often confrontational ways that people form communities around an issue and are supported in taking action to address that issue. More generally, publics and infrastructuring provide a new way to conceptualize the endeavor of PD and its connection to STS scholarship.

Enabling participation can be viewed as bringing in different voices as a way to frame the issue, which is to say that enabling participation allows stakeholders to engage in a discourse around known points of view. This is an important endeavor, certainly, but it is not the same as constituting a public. To constitute a public requires engaging in infrastructuring, because it is through infrastructuring that resources are developed, resources that allow groups of individuals to act in response to the inevitable issues arising from interaction and experience with socio-material things (in our case, community-focused technologies). Moreover, the ability of publics to form in anticipation of consequences provides opportunities for situating PD in evermore political conditions, conditions in which individuals and groups form as publics to take action in support of their desired futures.

Indeed, a move toward approaching PD as one of constituting publics, rather than products is consistent with a reformist or activist agenda of broadening the impact of PD (Shapiro, 2005). The act of infrastructuring is the core to supporting such an agenda because it moves past participation as a framing for design, toward participation as an ongoing act of articulating and responding to dynamic attachments. The public, however it might be constituted, is a socio-material response to these dynamics. The case studies we have presented here highlight the role technology design plays in the constitution of one or more publics and explores two different settings where infrastructuring occurred and furnished the actors involved with the tools and conceptual equipment needed to continually adapt their orientation and their use of the technology interventions to mitigate existing and future consequences.

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References

- Balka E (2006) Inside the belly of the beast: The challenges and successes of a reformist participatory agenda. In: *PDC '06: Proceedings of the ninth conference on participatory design*, Trento, Italy, 1–5 August 2006. New York: ACM Press, pp. 134–143.
- Beck EE (2002) P for political: Participation is not enough. *Scandinavian Journal of Information Systems* 14(1): 77–92.
- Björgvinsson E, Ehn P and Hillgren PA (2010) Participatory design and ‘democratizing innovation’. In: *PDC '10: Proceedings of the 11th biennial participatory design conference*, Sydney, Australia, 29 November–3 December 2010. New York: ACM Press, pp. 41–50.
- Borning A, Friedman B, Davis J and Lin P (2005) Informing public deliberation: Value sensitive design of indicators for a large-scale urban simulation. In: *Proceedings of the 9th European conference on computer-supported cooperative work* Paris, France, 18–22 September 2005. New York: Springer, pp. 449–468.
- Braun B and Whatmore SJ (eds) (2010) *Political Matter: Technoscience, Democracy, and Public Life*. Minneapolis, MN: University of Minnesota Press.
- Calhoun C (ed.) (1993) *Habermas and the Public Sphere*. Cambridge, MA: The MIT Press.
- Callon M, Lascoumes P and Barthe Y (2009) *Acting in an Uncertain World: An Essay on Technical Democracy* (trans. G Burchell). Cambridge, MA: The MIT Press.
- Carroll JM and Rosson MB (2007) Participatory design in community informatics. *Design Studies* 28(3): 243–261.
- Carstensen P, Schmidt K and Wiil UK (1999) Supporting shop floor intelligence: A CSCW approach to production planning and control in flexible manufacturing. In: *GROUP '99: Proceedings of the international ACM SIGGROUP conference on supporting group work*, Phoenix, Arizona, 14–17 November 1999. New York: ACM Press, pp. 111–120.
- Davis J (2009) Early experiences with participatory design of ambient persuasive technology. In: *CHI '09: Workshop on defining the role of HCI in the challenges of sustainability*, Boston, Massachusetts, 4–9 April 2009. New York: ACM Press, pp. 119–128.
- Dewey J (1954 [1927]) *The Public and Its Problems*. Athens, OH: Swallow Press.
- DiSalvo C and Lukens J (2009) Towards a critical technological fluency: The confluence of speculative design and community technology programs. In: *DAC '09: Proceedings of the 2009 digital and arts and culture conference*, Irvine, California, 12–15 December 2009. Irvine: University of California Press, pp. 1–5.
- DiSalvo C, Clement A and Pipek V (2013) Communities: Participatory design for, with and by communities. In: Simonsen J and Roberston T (eds) *Routledge International Handbook of Participatory Design*. New York: Routledge, pp. 182–209.
- DiSalvo C, Light A, Hirsch T, Le Dantec CA, Goodman L and Hill K (2010) HCI, communities and politics. In: *CHI EA '10: Proceedings of the 28th of the international conference extended abstracts on human factors in computing systems*, Atlanta, Georgia, 10–15 April 2010. New York: ACM Press, pp. 3151–3154.
- DiSalvo C, Louw M, Coupland J and Steiner MA (2009) Local issues, local uses: Tools for robotics and sensing in community contexts. In: *C&C '09: Proceeding of the seventh ACM conference on creativity and cognition*, Berkeley, California, 27–30 October 2009. New York: ACM Press, pp. 245–254.

- DiSalvo C, Nourbakhsh I, Holstius D, Akin A and Louw M (2008) The neighborhood networks project: A case study of critical engagement and creative expression through participatory design. In: *PDC '08: Proceedings of the tenth conference on participatory design*, Bloomington, Indiana, 30 September–4 October 2008. New York: ACM Press, pp. 41–50.
- Dryzek JS Goodin RE, Tucker A and Reber B (2009) Promethean elites encounter precautionary publics: The case of GM foods. *Science Technology & Human Values* 34(3): 263–288.
- Ehn P (1990) *Work-Oriented Design of Computer Artifacts*. Hillsdale, NJ: Lawrence Erlbaum Associates Inc.
- Ehn P (2008) Participation in design things. In: *PDC '08: Proceedings of the tenth conference on participatory design*, Bloomington, Indiana, 30 September–4 October 2008. New York: ACM Press, pp. 92–101.
- Fraser N (1993) Rethinking the public sphere: A contribution to the critique of actually existing democracy. In: Calhoun C (ed.) *Habermas and the Public Sphere*. Cambridge, MA: The MIT Press, pp. 109–142.
- Friedman B, Borning A, Davis JL, Gill BT, Kahn PH Jr, et al. (2008) Laying the foundations for public participation and value advocacy: Interaction design for a large scale urban simulation. In: *Dg.o '08: Proceedings of the 2008 international conference on digital government research*, Montreal, Canada, 18–21 May 2008. New York: ACM Press, pp. 305–314.
- Galloway A (2010) Locating media futures in the present, or how to map emergent associations and expectations. *Aether: The Journal of Media Geography* 5: 27–36.
- Habermas J (1991 [1962]) *The Structural Transformation of the Public Sphere: An Inquiry into a Category of Bourgeois Society*. Cambridge, MA: The MIT Press.
- Hildebrandt M and Gutwirth S (2008) Public proof in courts and jury trials: Relevant for PTA citizens' juries? *Science Technology & Human Values* 33(5): 582–604.
- Hirsch EA (2008) *Contestational design: Innovation for political activism*. PhD Thesis, Massachusetts Institute of Technology, US. Available at: <http://dspace.mit.edu/handle/1721.1/46594>
- Hirsch T, Sengers P, Blevis E, Beckwith R and Parikh T (2010) Making food, producing sustainability. In: *CHI EA '10: Proceedings of the 28th international conference extended abstracts on human factors in computing systems*, Atlanta, Georgia, 10–15 April 2010. New York: ACM Press, pp. 3147–3150.
- Karasti H and Baker K (2004) Infrastructuring for the long-term: Ecological information management. In: *Proceedings of the 37th Hawaii International Conference on System Sciences*, 5–8 January 2004. Piscataway, NJ: IEEE, pp. 1–10
- Latour B (2004) *Politics of Nature: How to Bring the Sciences into Democracy*. Cambridge, MA: Harvard University Press.
- Latour B (2007) *Reassembling the Social: An Introduction to Actor-Network-Theory*. New York: Oxford University Press.
- Latour B and Weibel P (eds) (2005) *Making Things Public: Atmospheres of Democracy*. Cambridge, MA: The MIT Press.
- Le Dantec CA (2012) Participation and publics: Supporting community engagement. In: *CHI '12: Proceedings of the 2012 ACM annual conference on human factors in computing systems*, Austin, Texas, 5–10 May 2012. New York: ACM Press, pp. 1351–1360.
- Le Dantec CA and Edwards WK (2008a) Designs on dignity: Perceptions of technology among the homeless. In: *CHI '08: Proceeding of the twenty-sixth annual SIGCHI conference on human factors in computing systems*, Florence, Italy, 5–10 April 2008. New York: ACM Press, pp. 627–636.
- Le Dantec CA and Edwards WK (2008b) The view from the trenches: Organization, power, and technology at two nonprofit homeless outreach centers. In: *CSCW '08: Proceedings of the ACM 2008 conference on computer supported cooperative work*, San Diego, California, 8–12 November 2008. New York: ACM Press, pp. 589–598.

- Le Dantec CA and Edwards WK (2010) Across boundaries of influence and accountability: The multiple scales of public sector information systems. In: *CHI '10: Proceedings of the 28th international conference on human factors in computing systems*, Atlanta, Georgia, 10–15 April 2010. New York: ACM Press, pp. 113–122.
- Le Dantec CA, Christensen JE, Bailey M, Farrell RG, Ellis JB, et al. (2010) A tale of two publics: Democratizing design at the margins. In: *DIS '10: Proceedings of the conference on designing interactive systems*, Aarhus, Denmark, 16–20 August 2010. New York: ACM Press, pp. 11–20.
- Le Dantec CA, Farrell RG, Christensen JE, Bailey M, Ellis JB, et al. (2011) Publics in practice: Ubiquitous computing at a shelter for homeless mothers. In: *CHI '11: Proceeding of the twenty-ninth annual SIGCHI conference on human factors in computing systems*, Vancouver, British Columbia, Canada, 7–12 May 2011. New York: ACM Press, pp. 1687–1696.
- Lievrouw LA (2006) Oppositional and activist new media: Remediation, reconfiguration, participation. In: *PDC '06: Proceedings of the ninth conference on participatory design*, Trento, Italy, 1–5 August 2006. New York: ACM Press, pp. 115–124.
- Light A, Simpson G, Weaver L and Healey PGT (2009) Geezers, turbines, fantasy personas: Making the everyday into the future. In: *C&C '09: Proceeding of the seventh ACM conference on creativity and cognition*, Berkeley, California, 27–30 October 2009. New York: ACM Press, pp. 39–48.
- Lippmann W (1993 [1927]) *The Phantom Public*. New Brunswick, NJ: Transaction Publishers.
- Luke R, Clement A, Terada R, Bortolussi D, Booth C, et al. (2004) The promise and perils of a participatory approach to developing an open source community learning network. In: *PDC '04: Proceedings of the eighth conference on participatory design*, Toronto, Ontario, Canada, 27–31 July 2004. New York: ACM Press, pp. 11–19.
- Marres N (2007) The issues deserve more credit: Pragmatist contributions to the study of public involvement in controversy. *Social Studies of Science* 37(5): 759–780.
- Merkel CB, Xiao L, Farooq U, Ganoë CH, Lee R, et al. (2004) Participatory design in community computing contexts: Tales from the field. In: *PDC '04: Proceedings of the eighth conference on participatory design*, Toronto, Ontario, Canada, 27–31 July 2004. New York: ACM Press, pp. 1–10.
- Pipek P and Wulf V (2009) Infrastructuring: Towards an integral perspective on the design and use of information technology. *Journal of the Association for Information Systems* 10(5): 306–332.
- Saeed S, Rohde M and Wulf V (2009) Technologies within transnational social activist communities: An ethnographic study of the European social forum. In: *C&T '09: Proceedings of the fourth international conference on communities and technologies*, University Park, Pennsylvania, 25–27 June 2009. New York: ACM Press, pp. 85–94.
- Sanders EBN (2005) Information, inspiration and co-creation. In: *6th international conference of the European Academy of Design*, Bremen, Germany, 29–31 March 2005.
- Sanders EBN (2006) Design research in 2006. *Design Research Quarterly* 1: 1–8.
- Shapiro D (2005) Participatory design: The will to succeed. In: *CC '05: Proceedings of the 4th decennial conference on critical computing*, Aarhus, Denmark, 20–24 August 2005. New York: ACM Press, pp. 29–38.
- Star SL and Bowker GC (2002) How to infrastructure. In: Lievrouw LA and Livingstone S (eds) *The Handbook of New Media*. London: SAGE, pp. 151–162.
- Star SL and Ruhleder K (1996) Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information Systems Research* 7(1): 111–134.
- Suchman LA (2007) *Human-Machine Reconfigurations: Plans and Situated Actions*. New York: Cambridge University Press.
- Turner F (2006) *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism*. Chicago, IL: University of Chicago Press.

- Twidale MB and Floyd I (2008) Infrastructures from the bottom-up and the top-down: Can they meet in the middle? In: PDC '08: Proceedings of the tenth anniversary conference on participatory design, Bloomington, Indiana, 30 September–4 October 2008. New York: ACM Press, pp. 238–241.
- Warner M (2005) *Publics and Counterpublics*. New York: Zone Books.
- Wilkie A and Michael M (2009) Expectation and mobilisation: Enacting future users. *Science Technology & Human Values* 34(4): 502–522.
- Wilkie A and Ward M (2009) Made in criticalland: Designing matters of concern. In: *Networks of design: Proceedings of the 2008 annual international conference of the design history society*, Cornwall, UK, 3–6 September 2008. Boca Raton, FL: Universal Publishers, pp. 118–123.
- Winner L (1980) Do artifacts have politics? *Daedalus* 109(1): 121–136.

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