7. Experiments in Participation

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Abstract

This chapter discusses the emerging body of work in STS that explores the experimental dimension of public participation in contemporary societies. This work moves beyond the original focus of STS on the role of experimentation in the sciences to consider the proliferation of experimental formats in the arts, social movements, economic organization, and public life. The chapter outlines several strands of scholarship that, through the study of experiments, have developed a materialist, situational and performative understanding of the making of publics in technological societies. At the heart of this scholarship lies a formative ambiguity: the fact that experiments in participation operate as both an *object* of inquiry and a *device* that actors including researchers themselves can deploy for the creation of new collectives. After reviewing how a focus on experimental situations was instrumental to the emergence of STS as a distinctive mode of inquiry, the chapter elaborates three recent themes from the literature: object-centered engagement, inventive methods, and prototyping. The chapter concludes by arguing that experiments in participation represent a crucial nexus of theory and practice in contemporary science, technology and society, one that allows the field to expand its repertoire of political tools and participate in wider experimental cultures.

Introduction

The idea that experiments represent key settings and instruments for participation

in public affairs has acquired a distinctly contemporary flavor. Social and political

experiments feature prominently in our daily lives, whether it is in the form of new entertainment genres, such as reality television, in the many media outlets that regularly report experimental findings from the social sciences, or in the multitude of recent government- and business-led experiments in behavioral change. When the social media company Facebook introduced a new button in its interface that allowed users to tell their "friends" that they had voted in recent U.S. and UK elections, this small technical intervention was presented as "an experiment" that pursued two inextricable goals: to foster greater political participation, on the one hand, and to gain new insights into the behavior of the platform's users and the ability of new interface features to alter their conduct (Healy 2015). Participatory initiatives that adopt an explicitly experimental orientation are now commonplace in urban planning, architecture, art, service design, the environment, and public health, to name a few prominent domains. In all these cases, lay or amateur audiences are invited to engage with technical, scientific, or aesthetic matters that used to be the preserve of experts, and to do so in an explicitly creative or innovative fashion that pushes the boundaries of traditional ways of enacting public affairs and performing democratic governance. The use in all these contexts of experimental formats, such as collaborative mapping tools or interactive exhibitions, is presented as a means of intensifying the generative potential of these participatory experiences, while in the process

producing new evidence and documentation about social and political life (Horst and Michael 2011). Deploying settings, devices, and/or things experimentally makes it possible to curate novel forms of participation, eliciting expressions or accounts of public issues that would otherwise remain underarticulated or exist only *in potentia* (Lury and Wakeford 2012; Marres, 2012).

The proliferation of experimental forms of participation has attracted the interest of STS researchers—not surprisingly, given the central place that experimentation occupies in science and technology studies. STS not only has studied the role that experimental practices and apparatuses have played in the evolution of the modern sciences but has also drawn attention to experiments as crucial occasions for the articulation of the relationship between science and society. Work in STS has long argued that experimental settings and situations not only play an important role in the acquisition of new knowledge about the natural or the social world but also offer exceptional opportunities for intervening in and changing those realities (Latour 1982). Yet as experiments are today explicitly designed and defined as a privileged format of participation in public life, an important question arises: can the proliferation of experimental formats facilitate meaningful engagement with public affairs, or does it threaten to impoverish or even undermine political democracy?

As "experiments in participation" are today undertaken across a range of settings and spheres, core concerns of STS become newly relevant to social and public life: preoccupations with the authority of experts and the distribution of agency in the design and interpretation of experimental data; the rhetorical power of public demonstrations and their capacity to elicit engagement, consent, and "lock-in"; or the role of experimental situations in recasting the relationship between natural and social domains. At the same time, by highlighting novel configurations of the relationship between experimentation and participation, recent work in this area puts to the test many received views in STS. For one, the proliferation of experimental formats in social, economic, and public life—such as "living experiments" conducted in domestic settings and collective experiments in "sustainable transitions" sponsored by industry or government—may imply that scientific registers of validity and value lose some of their hold over the deployment and interpretation of these interventions. Epistemological considerations must contend with alternative repertoires of evaluation, and experiments then bring into relation diverse knowledge cultures, innovation paradigms, and material practices, opening up new possibilities for encounters, exchanges, and conflicts among different constituencies. Partly as a consequence of this, experiments in participation acquire a formative ambiguity in relation to the nature and purposes of public life in technological societies: ostensibly meant

to enable new or enriched forms of participation, they also configure participation as an object of research, innovation, valuation, and manipulation (Chilvers and Kearnes 2016). This ambivalence—or rather "multivalence" (Marres 2012)—is key to elucidating the specific roles that experiments in participation can play in contemporary democratic politics.

This chapter discusses experiments in participation as an emerging nexus of research, theory, and practice in STS. It addresses a growing body of work that examines participation in public affairs—and the reconfiguration of situations, actors, and issues in participatory processes—as possessing a crucial experimental quality. To map out this field, the chapter draws together sometimes divergent strands of work in STS and cognate fields. We begin by briefly discussing the constitutive role of experiments as a research topic in the history of STS, including the significant body of work on experimentation in the social and political sciences. We then turn to an experimental practice of long standing in our field, namely, work in the field of public engagement with science (PES). Here, we focus on the growing segment of this literature that attends explicitly to the experimental and performative dimensions of participatory mechanisms. Finally, we review some current work on participatory experiments, organizing our discussion around three broad areas of concern: object-centered practices and forms of engagement; design, digital, and "inventive" methods; and public

experimentation as prototyping. Bringing these different strands of work into more explicit dialogue with one another is crucial if we are to fully grasp the distinctive features, possibilities, and challenges of experiments in participation as an STS method. We will conclude by making the case that current work in this area, while still very much under development, offers STS the opportunity to expand the range of its engagements with science and technology, and with research and innovation more broadly conceived. This expansion in the STS repertoire of intervention practices (see also chapter 8 this volume) should strengthen the ability of our field to participate in wider experimental cultures and contribute to the activation of new forms of collective imagination.

Experimentation in STS: Redefining Relations among Science, Technology, and Society

Experimentation was a key theme in the emergence of STS as an original field of research and scholarship. Paying close attention to the quandaries of experimental practices, describing in detail what scientists did in their laboratories and field sites, served as an explicit corrective to the traditional focus of the philosophy of science on already formalized knowledge and helped reformulate representation as a form of instrumentalized intervention (Hacking 1983).

This turn to experimentation advanced on a number of fronts. Historical studies of the rise of experimental cultures in the early modern period redefined the meaning of the Scientific Revolution and the Enlightenment, showing that the invention of modern experimental knowledge went hand in hand with the production of new kinds of audiences and publics. The choreography of demonstrations in the newly established "houses of experiment" or the founding of journals and other "literary technologies" for the dissemination of experimental findings created forms of public witnessing congruent with the sort of evidence that the new experimental ethos sought to produce (Dear 1985; Shapin 1988; Shapin and Schaffer 1985). In parallel, sociologists of scientific knowledge began to reevaluate the role of experiments in the establishment or refutation of scientific facts, focusing on the contingencies and paradoxes implied by any attempt to create universally valid and publicly legitimate knowledge through the staging of unique events held in closely guarded spaces (Collins and Pinch 1982). Last but not least, the physical presence of STS researchers in experimental settings, primarily as ethnographers of laboratory practices, gave us the first close look at science in action, revealing a world of artifacts, equipment, and inscription devices at odds with the sanitized version of fact-making conveyed by traditional epistemology (Latour and Woolgar 1979; Lynch 1985).

Why was experimentation such a productive focus for the development of the analytical sensibilities that would eventually coalesce into STS? The reasons are too many to list here, but it is clear that attending to experimental settings and situations was a powerful way of circumventing the traditional framework of epistemology. Classic distinctions in the philosophy of science, such as that between the "context of discovery" and the "context of justification" (Popper 1963; Reichenbach 1938) collapsed in the face of detailed investigations of experimental work that showed an inextricable combination of empirical and normative elements.

Experiments also confronted STS researchers with the unavoidable technical and material mediations of scientific knowledge production. Experimental settings were full of machinery, devices, and materials, and while philosophers of science had recognized the importance of these technical infrastructures as "conditions of possibility" for scientific knowledge production, STS demonstrated that artifactual elements played a far more active and formative role in the making of scientific knowledge, leaving their traces in the very claims advanced by the experimental sciences. If one wanted to understand the ability of experimental settings to settle controversies or establish new facts, it was imperative to come up with a better account of how nonhuman entities contributed to the production of scientific and social realities.

Furthermore, it became apparent that in the course of experimentation, theoretical constructions were often overtaken by the sheer productivity of research apparatuses. Experiments were best understood as highly choreographed practices whose performance, if successful, resulted in the production of surprises (Rheinberger 1997). The notion of "method" inherited from the philosophy of science, with its connotations of ordered procedures, predictable transitions, and replicable outcomes, had to be severely qualified, if not discarded altogether.

Finally, experiments drew explicit attention to practices of demonstration, the curation of controlled displays of evidence or instrumental action designed to persuade audiences of the existence of experimentally generated entities and phenomena (Collins 1988). The study of demonstrations proved the intimate connection between the validation of experimental knowledge and the creation of specific forms of public witnessing and testimony (Rosental 2013). They also drew attention to a crucial and highly productive ambiguity in the organization of public culture in scientific and technological democracies: the fact that *public* refers at once to genres, procedures, and apparatuses of knowledge-making (as in transparent or accountable), and to a distinctive kind of political collective, the gathering of strangers around a common object of interest (as in stakeholder or audience). The study of experimental demonstrations and public displays of technical competence thus became a strategic site for working out the evidentiary

underpinnings of different political cultures, whether it was the gentlemanly

polity of Restoration England (Shapin 1994; Shapin and Schaffer 1985), or the

liberal-democratic aspirations to transparency of the American republic and other

contemporary euro-American polities (Ezrahi 1990; Hilgartner 2000; Jasanoff

1998, 2005).

STS work on these issues has been primarily concerned with

experimentation in the natural sciences and engineering, but the field has also

harbored an expanding body of research on experiments in the social and political

sciences. This literature includes studies of the rise of experimental settings and

procedures in psychology (Danziger 1994; Lemov 2005; Mayer 2013) and of the

use of these settings and procedures for the articulation of social and political

issues (Gillespie 1993; Gross and Krohn 2005). Indeed, the role of the social

sciences in the development of new techniques for *representing the public to the*

public has been a central tenet of much of the recent historical scholarship (Igo

2007; Osborne and Rose 1999; Porter 1996). Work in STS often adds to these

discussions a closer examination of the technical apparatuses through which

social-scientific knowledge is produced (Derksen, Vikkelsø and Beaulieu 2012;

Haffner 2013; Lezaun and Calvillo 2014). It has drawn attention, for instance, to

the distinctly *situated* understanding of the experimental "truth spot" that

characterized classic sociological approaches to the "city as laboratory" (Gieryn

2006; see also Guggenheim 2012), or to how research technologies such as new survey designs made possible the expression of societal phenomena and their formatting for public and political intervention (Didier 2002).

These studies of the social and political sciences have particular relevance for the emergent STS approach to experiments in participation, since they concern situations in which the public is mobilized in at least three ways: (1) as the subject matter of a research apparatus, (2) as an audience for the evidence produced by that apparatus, and (3) as an active source (or agent) of knowledge about social and political matters. Indeed, as recent work in STS suggests, participation takes on here a three-fold significance. First, participation is instrumental to the production of experimental knowledge in an immediate, material way, as individuals, now recast as "research participants," must engage personally and directly with the experimental apparatus. Second, the organization of a certain public is also the goal of experimentation in the sense of seeking the valuation of knowledge propositions through specific forms of public witnessing. And third, participation is the object of scientific experimentation in a more indirect but no less pertinent sense: in their experimental interventions the social and political sciences articulate a particular vision of society and the polity, whether this relates to the capacities of social actors to know and act upon the world or to the possibility of envisioning, managing, or contesting social change. In a wider

sense, then, the nature of citizenship in democratic societies is inextricably linked to experimental performances, whether those involve the representation of the political will of the nation in an electoral contest (Miller 2004), unfold in the relative privacy of a focus group discussion designed to surface the hidden preferences of the population (Lezaun 2007), or involve the assembling of diverse actors to articulate issues in which they are jointly and antagonistically implicated, thus giving these issues a new public form (Callon, Lascoumes, and Barthe 2009; Marres 2007).

By expanding the range of matters at stake in experimental situations, STS has thus managed to revive the multiple connotations that have historically been attached to the notion of social experiment. Scientific demonstration or proof—the ability of an experiment to validate or refute a scientific hypothesis—is only one of several evidentiary registers available to assess the purpose of an experimental intervention. The category of "social experiment" is best understood as a format or genre that can circulate across scientific, professional, political, public and everyday settings—not simply as a procedure for testing social-scientific claims. Related literatures on the "enactment" or "happening" of "the social" (Law and Urry 2004; Lury and Wakeford 2012), studies of the role of experimental technologies and provocations in the constitution of markets and economies (Callon 2009; Muniesa 2014), or the developing research agenda on

"the social life of methods" (Law and Ruppert 2013) all speak to this growing interest in the ability of social scientific experimentation to *perform* collectives.

In sum, STS has long advanced the idea that experiments constitute a crucial site for bringing science, technology, and the public into intimate relation. In doing so, the field has offered an expansive account of experimentation as entailing not just a distinctive method of scientific inquiry but also a genre, an apparatus, and a particular form of publicity or sociality. The relation between experimental practices and their publics, in other words, is not that between an inside and an outside, between a scientific activity and its social or political context. The *public* of an experiment is not an ingredient added to the production of technoscience after the fact, so to speak, but a form of relationality that emerges—is invoked, put to the test, validated, or discarded—as part of the progress of the experiment itself (Marres 2009).

In advancing these arguments STS initiated a broad reconceptualization of publics and participation. As we will see, current STS scholarship makes a double move in relation to experiments and publics. By scrutinizing the role of experimentation in social and public life, it unsettles the question of how science, technology, and public relate or should relate to one another in contemporary societies. At the same time, STS researchers adopt experiments as a *resource or instrument for social and public inquiry*, developing their own experimental

techniques to probe and perhaps even alter the very meaning of democracy in technological societies. We will next revisit a significant tradition of experimental practice in STS: the creation of experimental situations designed to foster the public understanding of, or public engagement with, science and technology.

PUS/PES Experiments: Redistributing Expertise, Creating Public Situations

STS has long encompassed a set of experimental practices aimed at involving citizens in debates about science, technology, and society. A significant portion of the work that emerged in the 1980s under the rubric of the public understanding of science (PUS), and much of what nowadays is described as public engagement with science (PES), is informed by STS sensibilities and has a direct experimental dimension, even if this dimension has not always been articulated, or even acknowledged, in an overt fashion. Teasing out the implications of this tradition of experimentation leads to a more explicit consideration of how STS-inspired technical practices of participation can give form and help curate particular publics (Irwin 2001, 2006).

PUS/PES work in the STS tradition advocates the creation of opportunities for the public to engage with scientific research and technological innovation, and has typically understood engagement as participation in forums of deliberative

exchange. This strand of STS thus endeavors to create *situations of publicity*, formally designated and stage-managed occasions where members of the public are invited to discuss technoscientific topics, deliberate with experts, or question policy makers on controversial issues in science and innovation policy. In the pursuit of this agenda, the field has developed or used a series of semi-standardized formats of public participation, such as the consensus conference (Blok 2007; Grundahl 1995), citizen juries (Crosby, Kelly, and Schaefer 1986; Stilgoe 2007), multiple deliberative methodologies (Burgess et al. 2007; Rogers-Hayden and Pidgeon 2007), constructive technology assessment (Schot and Rip 1997), and hybrid forums (Callon, Lascoumes, and Barthe 2009).

The instrumental value of these methods to disclose hidden or tacit public opinions has progressively been overtaken, however, by a growing interest in their quality as experimental interventions in their own right (Felt and Fochler 2008, 2010). Public engagement events, in other words, can be approached as situations in which the expressions or accounts elicited by a participatory mechanism potentially disrupt any preformatting of issues, actors, or the participatory event itself. The question, as Michael (2012, 534) puts it, is, "What sort of events might our PUS/PES events precipitate that are not necessarily graspable within the frameworks informing the design of those events?" (See also Michael 2009.)

Coming to terms with the fact that STS conducts its own public experiments opens up new research questions. For instance, formats of public engagement can be subjected to an analysis inflected by STS sensibilities. Historical accounts of the origins and evolution of some of these techniques, such as Soneryd's (2016) work on scenarios workshops, or Voß and Amelung's (2016) study of citizen panels, show the tortuous biography of the deliberation tools adopted by STS. Indeed, multiple studies have recently examined the complicated transportation of participatory methods into new contexts and issues. Laurent has described, for instance, the attempted replication of a participatory device—the consensus conference pioneered by the Danish Board of Technology—for a novel technoscientific area—nanotechnology—and in two different countries—the United States and France (Laurent 2009). The difficulties encountered in preserving a seemingly ready-made format across political or scientific domains allow Laurent to make visible "the investments and works that are required to replicate and stabilize forms of public participation" (Laurent 2009, 2). At the same time, the "cracks and gaps" that emerge as a participatory device is stretched to meet a new topic or operate in a new environment provide opportunities to explore the "ambivalence" inherent in participation procedures—an ambivalence that, Laurent argues, ought to be part of our definition of successful public participation.

Describing a similar sort of travel and a similarly vexing process of experimental replication, Ureta (2015) has explored the use of the consensus conference format in Chile to encourage further public engagement on the management of patient health records. In Ureta's account, the format travels well to the new environment as far as its ability to generate a discrete moment of deliberation and consensus is concerned, but it fails to live up to the implicit promise to revamp the role of citizens in the oversight of patient records. The experiment, in other words, did not contribute to an intensification of public engagement with the issue at hand, serving only to realize, as Ureta puts it, "a small and secluded version of Danish democratic deliberation in the midst of the Chilean wilds" (Ureta 2015, 11; see also Bogner 2012). In a similar vein, Tironi (2015) has described the deployment of the "hybrid forum" model in the context of postdisaster reconstruction in Chile. Originally introduced as an apparatus to radicalize public engagement, in Chile the model encountered publics that did not behave as predicted by the choreography of theories, principles, and methodological protocols articulated in this experimental formula. By exploring the assumptions about democracy, politics, and participation that were brought along with the model as it traveled from Europe to Chile, Tironi challenges the expectation of transportability that is often attached to experimental political forms.

Exploring public engagement as an experimental practice reveals some obvious but long-neglected empirical realities. Much of the PUS/PES literature had initially defined public participation rather narrowly, characterizing engagement as a discursive phenomenon involving primarily talk and the expression of views and opinions, and specifying its features in terms of procedural rules and roles. In contrast, approaching public engagement events as experimental interventions immediately draws our attention to the fact that these events are saturated with things, machines, and other stuff, that they unfold in settings and under material conditions specifically tailored to the requirements of participatory action (Davies et al. 2012; Marres and Lezaun 2011). In their work on "competency groups," for instance, Whatmore and Landström (2011) explore how civic involvement with controversies—in this case flood defense schemes in rural Yorkshire (UK)—is enabled through the deployment of seemingly mundane artefacts, as when participants were invited to bring along a relevant object, and a piece of carpet salvaged during a recent flood came to instantiate the issues at hand. Drawing on the work of Isabelle Stengers and Karen Barad, Whatmore and Landström argue for the invention of research apparatuses that can "slow down" expert reasoning and redistribute agency among specialists, lay people, and nonhuman entities. In a similar vein, Waterton and Tsouvalis (2015) show how public engagement with lively materials—this time cyanobacteria in the Lake

District—led to envisioning a new form of relationality of people and things, what they describe as an "intra-active collective politics."

While this emerging body of work develops a broad normative argument in favor of an experimental approach to participation, it is also increasingly alert to the crucial question of whether—and how—discrete settings and moments of experimentation can index wider political constellations (Barry 2001, 2013; Lezaun 2011). The question of the experimental performance of democracy and the role of knowledge and technology in public life is thus posed anew, this time around the connectivity of discrete experimental interventions (Laurent, in press). In a recent volume entitled *Remaking Participation*, Chilvers and Kearnes (2016, 52) offer an "ecological" perspective on this question, arguing that "it is not possible to properly understand any one collective of participation without understanding its relational interdependence with other participatory practices, technologies of participation, spaces of negotiation, and the cultural-political settings in which they become established."

This ecological perspective has direct implications for STS, as it can be one of the actors analyzing and contributing to the configuration of "relational interdependence" of situated experiments in participation. Exploring the potential role of STS as a mediator or connector requires, however, reflexive attention to the formation and deployment of STS participatory expertise (Chilvers 2008a,

2008b), a critical examination of the discursive and instrumental dimensions of STS' experimental practice (Felt 2016; Lezaun and Soneryd 2007; Tironi 2015; Voß, 2016), and a continuing exploration of how the production of epistemic orders, including those of our own making, relates to the stabilization or disruption of institutional and political dynamics (Ezrahi 2012; Jasanoff 2004). The confluence of much of this work around concepts such as "technologies of humility" (Jasanoff 2003) or "technologies of democracy" (Laurent 2011) and the willingness to consider our own participatory experiments as part and parcel of the contested emergence of new technoscience (Bellamy and Lezaun 2015; Irwin, Jensen, and Jones 2013; Stilgoe 2015) express a commitment to develop an approach that recognizes the confluences, asymmetries, and tensions among science, social science, political democracy, and social democracy, and the modest but significant role that our field can play in modulating those relationships.

New Themes: Experiments in Participation Unbound

Alongside the well-established tradition of PUS/PES work in STS, several emerging strands of work are contributing to shifting the emphasis of work in this area from treating experiments as objects of STS study to approaching them as devices of STS research, and from considering experimentation as a procedural

activity in which actors take part to exploring how the condition of experimentality enables the enactment of actors and their relationships in specific ways. This shift takes advantage of the aforementioned ambiguity of experiments as both objects of and resources for research on science, technology, and society. In this section we will organize our discussion by foregrounding three distinctive themes in this emerging literature: object-centered engagement, inventive methods, and prototyping. Each of these themes brings with it different empirical and conceptual definitions of experimentation, showcasing the diversity of approaches that characterizes current STS work in this area.

Object-Centered Engagement: Expanding the Settings of Participation.

Renewed attention to the role of material objects in public participation processes has helped reorient the study of science, technology, and democracy toward contemporary challenges. Specifically, it has broadened the concept of experimentation to denote not just the methods and techniques used to curate particular forms of public participation but also the specific capacities of the often mundane objects and devices used to this end. Everyday things such as thermostats and wristbands acquire the capacity to mediate involvement with issues such as climate change and public health (Hawkins 2011; Wilkie 2014).

Marres's (2012) work on "material participation," for instance, observes that governments, corporations, and civil society organizations configure everyday material practices as significant sites of participation in problems such as climate change. The fact that people are materially implicated in this issue by way of everyday practices—such as cooking, heating, or gardening—provides an opening for object-centered and technological strategies for societal change, including "ethical consumption" and "behavioral change." But the material implication of actors also provides opportunities for the experimentalization of political participation and the development of alternative formats of ecological involvement. Marres develops this argument through an analysis of everyday practices of engagement with climate change and environmental sustainability, including so-called living experiments. These experiments serve to thematize— that is, to make public—the implicit normative powers of material objects, their capacity to implicate us in matters of common concern and to put our ontological commitments to the test (see also Murphy 2006).

In reframing participation as something done with things, however, this strand of work also highlights that participation is not contained or overdetermined by its location. In his analysis of the formation of a new collective around the issue of consumer debt, for instance, Joe Deville (2015) pays particular attention to how individuals deploy the letters they receive from debt collection

agencies to organize into a consumer debt public. They do so by uploading the documents onto online discussion forums dedicated to the topic of consumer debt, thus employing private communications to stage public demonstrations of the issues of consumer indebtedness, using the letters as a sort of lure to enable wider political engagement with the issue. This and other examples of how mundane, everyday objects can feature in the formation of publics suggest that the efficacy of participation initiatives derives to some extent from the experimental qualities that these objects acquire when they are deployed *in* and *as* the apparatus of participation.

Experiments in participation are in this sense object-dependent, insofar as everyday things such as thermostats or debt collection letters can bear an explicit normative or political charge that enables new forms of participation. This object dependency, however, does not imply that these experiments are dependent on a specific physical setting (e.g., the laboratory) or a specific procedure of participation (e.g., the debate). These "political things" are circulating objects. Furthermore, these objects not only include discrete or concrete entities—such as household appliances —but much more fluid and complex material realities— such as the (green) electricity grid (Schick and Winthereik 2013), the (polluted) atmosphere (Tironi and Calvillo 2016), or the Internet of Things (Gabrys 2014). When we consider these scattered techno-environmental arrangements it become

clear that objects do not just play a role as props—rhetorical devices that dramatize the issue or demand in question—but operate also as diffuse mediators with specific powers of engagement and the material element in which engagement may find its practical justification (Marres 2009). By the same token, referring to participation initiatives as experiments does not just highlight their intrinsic potential to generate surprises or unexpected results but also implies that these initiatives often serve to test the capacity of objects, as well as subjects, to render wider issues relevant, above and beyond already-established problem definitions. This entails a further reframing of publicity and participation in relation to science and technology; rather than being simply objects worthy of public participation, distributed material practices of research and innovation become a distinctive register of participation in public problems.

Furthermore, work on the role of material objects in participation multiplies the traditions of experimentation relevant to the enactment of participation, loosening the hold of scientific understandings of experimentation in liberal democracy. In her previously mentioned work on sustainable living experiments and demonstrational ecohomes, Marres (2012) shows how these devices and practices draw on a variety of experimental formats, originating, for instance, in the monitoring of building performance in construction research, in ecological movements committed to living "in tune with nature," or in formats of

marketing research designed to assess people's willingness to engage. Similarly, feminist-informed work in STS by scholars like Murphy (2006), Roberts (2006) and Puig de la Bellacasa (2014) demonstrates the intersection of multiple experimental forms in lay and scientific practices of environmental monitoring, as moral traditions focused on the care for the self are brought into relation with a technoscientific and/or ecological preoccupation with the monitoring of chemicals in the environment. The body as a site of experimentation and an incarnation of public evidence has also been front-staged in recent STS-inspired work on atmospheric contamination and "chemical attunement" that similarly highlight the precarious existence of technologically mediated collectives (Shapiro 2015; see also Choy 2011; Tironi 2014b).

In sum, a variety of genealogies and understandings of experimentation intersect in object-oriented approaches to participation, and STS researchers pay particular attention to how this cross-fertilization of different traditions, knowledges, and skills shapes contemporary politics. For one, the multiplicity of relevant traditions signals that experiments in participation are often unstable in terms of the political agenda they further—they are highly malleable and appropriable by a multitude of constituencies. For example, while the aforementioned scenario workshop methodology was invented to further the goals of the ecology movement and extend awareness to distant futures, it was

subsequently adopted and absorbed by oil companies to organize debates among their own stakeholders. Partly for this reason, STS work in this area is not particularly interested in fixing the meaning of any given participatory experiment—for example, by anchoring it in a singular experimental tradition, scientific, political, or artistic. Instead, greater sensitivity to the variability of participatory forms has reactivated a commitment to what we might call a politics of underdeterminacy. Seen from this perspective, the multivalence of participatory experiments does not denote a lack of consistency or dependability; it rather points to their ability to circulate across multiple domains, facilitate encounters between different traditions and sensibilities, and enable ways of articulating public concerns that cannot be fully anticipated or contained by any given design.

Inventive Methods in STS: Experiments between What Is and What Might Be

As we noted earlier, the broadening of the STS perspective on participation to include material and technological practices has led STS researchers to reconsider their own role in experiments in participation. One reason for this is fairly simple: as a wider range of devices is used by a variety of actors in policy, activism, social research, art and design to foster participation, STS researchers have started

to wonder how they may productively take up such instruments themselves. But there is also a more complex reason: as STS researchers account for participation in performative terms—as something accomplished through the deployment of settings, devices, and objects –participation as a topic is to some extent destabilized. Devices of participation may of course still be approached as an object of study, but they also represent a possible resource to be deployed, and often (a bit of) both at the same time. How can we deploy this ambiguity in STS research? And what politics of knowledge would it enable?

Before further discussing this methodological challenge, we want to emphasize that these shifts in STS approaches to participation are partly predicated on empirical developments. The dissemination of digital technologies is perhaps the most salient among these. For example, Plantin (2015) and Petersen (2014) have described the role of online mapping technologies in allowing new forms of public engagement in the context of emergencies—the 2007 San Diego wildfires and the Fukushima Daiichi nuclear disaster in 2011. In these cases, digital technologies are configured as instruments of participation—citizens can use online cartographic tools to assemble data and in the process constitute themselves as a new public. At the same time, online mapping tools can be used to conduct research *on* participation, producing for instance new evidence on which lay communities collected and uploaded radiation data in the aftermath of

the Fukushima disaster. Digital technologies thus invite STS researchers to reflect on the increasing continuities between the technical apparatuses of participatory research that we seek to analyze and the technologies that we may wish to deploy in our own investigative work.

This multifaceted nature of technologies of participation—as both object and device of social research—has led some STS researchers to take the next step and get involved in the design and development of experimental devices (Jalbert and Kinchy 2015). This work is sometimes framed as a contribution to the development of inventive methods for social and cultural research (Lury and Wakeford 2012). The characteristic STS orientation toward the performative capacities of devices, objects, and settings—their ability to bring new phenomena into being—is translated here into efforts to deploy those entities experimentally with the aim of eliciting participation as a phenomenon to both cultivate and investigate.

Thus, the Austrian-Swiss collective Xperiment! uses creative drawing techniques to allow elderly patients to record and visualize their everyday lives, a project that results not only in a series of written research articles but also in gallery installations where the drawings are displayed (Kraeftner and Kroell 2005; see also Guggenheim 2011). In another example of inventive methods at work, Wilkie, Michael, and Plummer-Fernandez (2014) explore the topic of "energy

demand reduction and community engagement" by creating an experimental device of participation, the Energy Babble Box. This device combines a radio function—broadcasting content from the web and social media that deals with energy demand—with the interactivity offered by a microphone—allowing users to input their own "energy talk" into the device and to circulate this talk to other users of the Energy Babble Box. The experimental device facilitates at least three distinct operations upon participation in energy demand reduction: it renders visible current enactments of energy publics, it facilitates a playful engagement with the issue, and it offers speculative proposals for the reorganization of participation in this area. By deploying creative devices to organize experiments in engagement, this and similar STS-informed projects embrace the formative ambiguity of devices to open up an interstitial space between research and development, reworking this traditional opposition to enable a movement or oscillation between the observation of what is given and the cultivation of new entities and relations.

Finally, efforts to render the performative capacities of methods and technologies productive for social and cultural research are being pursued extensively in digital media studies and digital social research. Some work in this area is inspired by STS research on the politics of technology and the politics of method and seeks to deploy dominant digital devices—like search engines and

social media analytics—for the study of public controversies and issue formation around science, technology, and society. This is, for instance, the case with the Issue Crawler, a web-based research tool for the location and analysis of "issue networks" online (Rogers 2010; Rogers and Marres 2000), or the Twitter Capture and Analysis Toolkit (T-CAT) developed at the University of Amsterdam (Borra and Rieder 2014). These instruments adapt tools of online data capture, analysis and visualization to enable research on issue formation by academics, activists, advocates, journalists, and so on. Arguably, these interventions can be qualified as experiments in participation in themselves: by taking up and repurposing research instruments and infrastructures that were developed and are largely owned by private and for-profit organizations, they test the feasibility of a more public-oriented form of inquiry by digital means.

In sum, the various projects discussed in this section draw on and engage with very different traditions of practice-based work—product design, data visualization, installation art and software development —but they have in common an orientation toward the performative capacities of devices and settings of participation and a commitment to move from the description of such settings and devices to their design and deployment. They attempt to open up a space between knowledge and invention, conjuring up forms of participation that would otherwise remain unavailable and that, in many respects, are yet to be fully

imagined. In doing so, STS researchers adopt the role of participants in wider research and innovation cultures, seeking to enrich and radicalize traditional ways of conceiving and doing participatory research and design.

Experimentation as Prototyping: Participation in Times of Environmental, Technological, and Social Change

While much of the work discussed so far focuses on specific devices of public engagement, a growing literature highlights the broader ontological, epistemic, and political contexts in which experiments in participation become salient. Current research in STS focuses, for instance, on the forms of political experimentation that are deployed in postdisaster situations. In his study of participation initiatives in the wake of the 2010 earthquake in Talca, Chile, Tironi (2014a) argues that the disaster, as a particular social phenomena located in the space between radical ontological uncertainty and the need for immediate action, gave rise to an iterative and all-encompassing form of experimentation (see also Tironi and Calvillo 2016). Here, the experiment in participation does not refer simply to a discrete apparatus used to elicit solutions to preestablished problems but points to a broader experimental atmosphere in which questions, solutions, and their context of application are speculated into being in the face of complete uncertainty. In other words, the concept of experiment does not just pertain to the

methods and technologies deployed to engage people in current affairs. Disasters produce deep disturbances in ingrained ways of being and doing, forcing a radical experimentalization of the questions of how to live, and how to live together. They offer a most vital demonstration of the motto "No issue, no public" (cf. Marres 2005).

To use the concept of the experiment as a heuristic for the study of engagement practices also enables a different understanding of what it means to change the settings of participation. By approaching participation not as a procedure or mechanism but as an experimental practice, it becomes possible to loosen the association between participation and stabilization—to unsettle the assumption that participation primarily serves the ends of steadying or fixing a certain situation by providing legitimacy or ensuring consent. Participatory practices can serve as a source of more disruptive kinds of social and political experimentalism, novel ways of equipping actors to deal with change in the face of pressing issues (e.g., climate change), extreme settings (e.g., disasters), and/or recalcitrant objects (e.g., digital infrastructures). The understanding of experiments in participation developed in social and political theories of scientific and technological democracy, which foregrounds how experimental arrangements serve to enact publics, encounters here a different notion of experimentation, one that traces its genealogy to progressive social movements, technological cultures,

and the arts. Experiments provide settings for collective tinkering in vivo with objects and environments whose status and value are called into question with the emergence of a new political situation (Estalella and Sánchez-Criado 2015).

Attention to collaborative experimentation has been particularly productive in the intersection of STS with the fields of architecture, urbanism, environmentalism, and the "maker culture" (Corsín-Jiménez, Estalella, Zoohaus Collective 2014; Farías 2015; Guggenheim 2011; Jungnickel 2013; Nold 2015; Papadopoulos 2015; Yaneva 2013). In this work, the city, the region, the neighborhood, or the project—architectural, urban, environmental, or otherwise—emerges as a concrete site in which innovation and development may be politicized, becoming a focal point of creative and material experimentation. Crucially, these experiments serve multiple purposes all at once: they mediate between institutions and communities, bring diverse actors together (sometimes to dramatize their differences), produce hands-on solutions, pilot unorthodox technologies, and, last but not least, test new ways of articulating issues. The experiment is a way of shifting the initiative, of demonstrating that people possess greater capacities to transform the conditions of their everyday life than they had previously assumed.

It should by now be apparent that to study experiments in participation does not imply that we scale down our perspective on democracy—or on science

and technology, for that matter—and consider only the most immediate environments in people's daily lives. For one, much of the work on experiments in participation discussed so far stresses the public mediation of these experiments by media technologies. Experiments enable the assembling of new collectives around contentious objects that are, at the same time, the political, epistemological, and environmental media through which these collectives seek to act. Any modification of those objects of engagement is simultaneously an intervention into the conditions of publicity of those collectives—and vice versa. This is the idea conveyed by Kelty's concept of recursive publics in his work on the free software movement. These are publics that operate directly, both discursively and materially, on the infrastructures that allow their coming into being. These collectives "argue about technology, but they also argue through it. They express ideas, but they also express infrastructures through which ideas can be expressed (and circulated) in new ways" (Kelty 2008, 29; see also Coleman 2014).

The normative effect of this recursive logic is what could be labeled, after the work of Corsín-Jiménez and Adolfo Estalella on open source urbanism (Corsín-Jiménez 2014a), a politics in beta: an experimental mode of inquiry in which constantly changing conditions, materials, and spaces invoke an equally mutable and transient public sphere. Corsín-Jiménez uses the figure of the

prototype to bring into theoretical relief the political implications of such collective experiments. Prototyping, in this context, is not just a particular way of configuring and staging a technical device—as is the case with the release of beta, nonstable, or work-in-progress versions in software or architectural development—but a process characterized by the "mutual prefiguration of objects and sociality" (Corsín-Jiménez 2014b, 383). Prototyping, as Corsín-Jiménez puts it, should be investigated "as something that happens to social relationships when one approaches the craft and agency of objects in particular ways" (ibid., 383). In their work with disability and independent-living activists in Barcelona, Sánchez-Criado, Rodríguez Giralt, and Mencaroni (2015) present a collaborative process of open-source prototyping aimed at tactically altering the urban spaces that constrain movement. Through targeted material interventions, such as the design and deployment of portable wheelchair ramps, these interventions do not simply produce a public statement about the need for more inclusive cities but also exemplify a practical way of doing this inclusiveness—they make manifest the process of "taking part in the definition of the technical and material aspects defining independent living" (Sánchez-Criado, Rodriguez Giralt, and Mencaroni 2015, 14). In this particular context, STS is explicitly cast as a practical resource in the quest for new collaborative methods and solutions (also see Gabrys and Pritchard, 2015).

Conclusion: Linking Up the Experimental Dimensions of STS

It should by now be clear why we believe the theme of experiments in participation represents a productive nexus of theory and practice for STS. Not only does it help us think about the technoscientific dimension in politics, or about the politics of technoscience, but it also broadens the domains of science, technology, and innovation to help us attend to a much wider range of practices of research and invention across social, cultural, and political life. This broadening is certainly not meant to undo the commitment to specificity, granular description, and empirical situatedness that has been distinctive of much of the best work in STS. It is rather a way of following through on the original commitment to a symmetrical treatment of science and its publics, of technical expertise and other ways of knowing and acting in the world.

We have approached the theme of experiments in participation as a channel to include the creative and generative practices of design, art, computing, digital media, and architecture in the fields of STS—a way of recognizing the critical role these practices play today in bringing science, innovation, and society into new sorts of relationships with one another. A focus on experiments in participation allows us to recognize an expansion of the registers of participation

in technological societies. Participation in public affairs is performed today in a multitude of everyday, workplace, cultural, environmental, and digital settings and media. Multiple traditions of experimentation are relevant to these performances—not only those of institutional technoscience but also many that emanate from social movements, computing, creative practices, and the arts (Born and Barry 2010; Gabrys and Yusoff 2012).

Participatory experiments thus represent contact zones between different traditions of experimentation, and demand that we develop modes of analysis and intervention that distribute the initiative more evenly across diverse and heterogeneous forms of practice. While STS shares this overarching objective with other approaches and agendas, such as those of digital culture or ecological politics, it is our view that the conceptual, empirical, and normative sensibilities of STS have a crucial role to play in this task. STS offers critical intellectual resources that we simply cannot do without if we are to address key political risks of contemporary technological societies: the lasting appeal of technological determinism, renewed assertions of the sovereign power of expert authority, and the narrow framings of "evidence-based" policy – framings that sometimes infuse digital culture, the creative economy, or sustainability transitions almost as much as they do technoscience.

Finally, we have emphasized that experiments in participation are a productive field for the further development of STS scholarship because their formative ambiguity makes it possible to reframe and elaborate key insights and approaches of the field. Experiments in participation represent important phenomena to be described and analyzed as well as instruments to be deployed in intervention-oriented strands of STS. This dual character offers an opportunity to elaborate the reflexive capacities of our field. In experiments in participation, the characteristic STS orientation toward the constructed, performed, and technologically mediated nature of our world becomes deployable as part of the conduct of social and political inquiry; our analytical and critical sensibilities can be put to the test in the process of curating new public situations. Elaborating the experimental dimensions at the core of STS will bring our field into a more productive dialogue with broader contemporary efforts to redefine democratic culture in technological and knowledge-intensive societies. The larger aim of STS research and intervention, however, remains the same as it has been for the last few decades, namely, to activate new collective imaginations of what an epistemically, technically, environmentally and materially engaged polity might be.

References

Barry, Andrew. 2001. *Political Machines: Governing a Technological Society*.

　　London: Athlone Press.

___. 2013. *Material Politics: Disputes along the Pipeline*. West Sussex: Wiley-

　　Blackwell.

Bellamy, Rob, and Javier Lezaun. 2015. "Crafting a Public for Geoengineering."

　　Public Understanding of Science, Published online before print August 27,

　　2015. doi:10.1177/0963662515600965.

Blok, Anders. 2007. "Experts on Public Trial: On Democratizing Expertise

　　through a Danish Consensus Conference." *Public Understanding of*

　　Science 16 (2): 163–82.

Bogner, A. 2012. "The Paradox of Participation Experiments." *Science,*

　　Technology & Human Values, 37 (5): 506–27.

Born, Georgina, and Andrew Barry. 2010. "Art-Science: From Public

　　Understanding to Public Experiment." *Journal of Cultural Economy* 3 (1):

　　103–19.

Borra, Erik, and Bernhard Rieder. 2014. "Programmed Method: Developing a Toolset for Capturing and Analyzing Tweets." *Aslib Journal of Information Management* 66 (3): 262–78.

Burgess, Jacquelin, Andy Stirling, Judy Clark, Gail Davies, Malcolm Eames, Kristina Staley, and Suzanne Williamson. 2007. "Deliberative Mapping: A Novel Analytic-Deliberative Methodology to Support Contested Science-Policy Decisions." *Public Understanding of Science* 16 (3): 299–322.

Callon, Michel. 2009. "Civilizing Markets: Carbon Trading Between in Vitro and in Vivo Experiments." *Accounting, Organizations and Society* 34 (3): 535–48.

Callon, Michel, Pierre Lascoumes, and Yannick Barthe. 2009. *Acting in an Uncertain World*. Cambridge, MA: MIT Press.

Chilvers, Jason. 2008a. "Deliberating Competence: Theoretical and Practitioner Perspectives on Effective Participatory Appraisal Practice." *Science, Technology & Human Values* 33 (3): 421–51.

___. 2008b. "Environmental Risk, Uncertainty, and Participation: Mapping an Emergent Epistemic Community." *Environment and Planning* A 40 (12): 2990–3008.

Chilvers, Jason, and Matthew Kearnes, eds. 2016. *Remaking Participation: Science, Environment and Emergent Publics*. London: Routledge.

Choy, T. K. 2011. *Ecologies of Comparison: An Ethnography of Endangerment in Hong Kong*. Durham, NC: Duke University Press.

Coleman, G., 2014. *Hacker, Hoaxer, Whistleblower, Spy: The Many Faces of Anonymous*. London: Verso Books.

Collins, H. M. 1988. Public experiments and displays of virtuosity: The core-set revisited. *Social studies of science*, 18(4), 725-748.

Collins, Harry, and Trevor Pinch. 1982. *Frames of Meaning: The Social Construction of Extraordinary Science*. London: Routledge and Kegan Paul.

Corsín-Jiménez, Alberto. 2014a. "The Right to Infrastructure: A Prototype for Open Source Urbanism." *Environment and Planning D: Society and Space* 32 (2): 342–62.

___. 2014b. "Introduction: The Prototype: More Than Many and Less Than One." *Journal of Cultural Economy* 7 (4): 381–98.

Corsín Jiménez, Alberto, Adolfo Estalella, and Zoohaus Collective. 2014. "The Interior Design of (Free) Knowledge." *Journal of Cultural Economy* 7 (4): 493–515.

Crosby, Ned, Janet Kelly, and Paul Schaefer. 1986. "Citizens Panels: A New Approach to Citizen Participation." *Public Administration Review* 46 (2): 170–78.

Danziger, Kurt. 1994. *Constructing the Subject: Historical Origins of Psychological Research*. Cambridge: Cambridge University Press.

Davies, Sarah R., Cynthia L. Selin, Gretchen Gano, and Ângela G. Pereira. 2012. "Citizen Engagement and Urban Change: Three Case Studies of Material Deliberation." *Cities* 29 (6): 351–57.

Dear, Peter. 1985. "Totius in Verba: Rhetoric and Authority in the Early Royal Society." *Isis* 76 (2): 145–61.

Derksen, M., Vikkelsø, S. and Beaulieu, A., 2012. Social technologies: Cross-disciplinary reflections on technologies in and from the social sciences. *Theory & Psychology*, 22(2), pp.139-147.

Deville, Joe. 2015. *Lived Economies of Default: Consumer Credit, Debt Collection and the Capture of Affect*. London: Routledge.

Didier, Emmanuel. 2002. "Sampling and Democracy: Representativeness in the First United States Surveys." *Science in Context* 15 (3): 427–45.

Estalella, Adolfo, and Tomás Sánchez-Criado. 2015. "Experimental Collaborations: An Invocation for the Redistribution of Social Research." *Convergence: The International Journal of Research into New Media Technologies* 21 (3): 301–5.

Ezrahi, Yaron. 1990. *The Descent of Icarus: Science and the Transformation of Contemporary Democracy*. Cambridge, MA: Harvard University Press.

___. 2012. *Imagined Democracies: Necessary Political Fictions*. Cambridge: Cambridge University Press.

Farías, Ignacio. 2015. "Epistemic Dissonance: Reconfiguring Valuation in Architectural Practice." In *Moments of Valuation: Exploring Sites of Dissonance*, edited by Ariane Berthoin Antal, Michael Hutter, and David Stark, 271–89. Oxford: Oxford University Press.

Felt, Ulrike. 2016. "The Temporal Choreographies of Participation: Thinking Innovation and Society from a Time-Sensitive Perspective." In *Remaking Participation: Science, Environment and Emergent Publics*, edited by Jason Chilvers and Matthew Kearnes, 178–98. London: Routledge.

Felt, Ulrike, and Maximilian Fochler. 2008. "The Bottom-up Meanings of the

Concept of Public Participation in Science and Technology." *Science and

Public Policy* 35 (7): 489–99.

___. 2010. "Machineries for Making Publics: Inscribing and De-scribing Publics

in Public Engagement." *Minerva* 48 (3): 219–38.

Gabrys, Jennifer. 2014. "Programming Environments: Environmentality and

Citizen Sensing in the Smart City." *Environment and Planning D: Society

and Space* 32 (1): 30–48.

Gabrys, Jennifer, and Helen Pritchard. 2015. "Just Good Enough Data and

Environmental Sensing: Moving Beyond Regulatory Benchmarks toward

Citizen Action." In "Environmental Infrastructures and Platforms 2015 –

Infrastructures and Platforms for Environmental Crowd Sensing and Big

Data Proceedings of the Workshop," Proceedings of the European Citizen

Science Association General Assembly, Barcelona, Spain, 28-30 October,

2015, eds. Arne J. Berre, Sven Schade, and Jaume Piera.

Gabrys, Jennifer, and Kathryn Yusoff. 2012. "Arts, Sciences and Climate Change:

Practices and Politics at the Threshold." *Science as Culture* 21 (1): 1–24.

Gieryn, Thomas. 2006. "City as Truth-Spot Laboratories and Field-Sites in Urban

Studies." *Social Studies of Science* 36 (1): 5–38.

Gillespie, Richard. 1993. *Manufacturing Knowledge: A History of the Hawthorne Experiments*. Cambridge: Cambridge University Press.Gross, Matthias, and Wolfgang Krohn. 2005. "Society as Experiment: Sociological Foundations for a Self-experimental Society." *History of the Human Sciences* 18 (2): 63–86.

Grundahl, Johs. 1995. "The Danish Consensus Conference Model." In *Public Participation in Science: The Role of Consensus Conferences in Europe*, edited by Simon Joss and John Durant, 31–40. London: Science Museum.

Guggenheim, Michael. 2011. "The Proof Is in the Pudding. On 'Truth to Materials' in STS, Followed by an Attempt to Improve It." *Science Technology and Industry Studies* 7 (1): 65–86.

___. 2012. "Laboratizing and De-laboratizing the World: Changing Sociological Concepts for Places of Knowledge Production." *History of the Human Sciences* 25 (1): 99–118.

Hacking, Ian. 1983. *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. Cambridge: Cambridge University Press.

Haffner, J. 2013. *The View from Above: The Science of Social Space*. Cambridge, MA: MIT Press.

Hawkins, Gay. 2011. "Packaging Water: Plastic Bottles as Market and Public Devices." *Economy and Society* 40 (4): 534–52.

Healy B. (2015.) "Facebook Button Lets Users Tell Friends They Voted in UK Election," *Mashable*, May 5, 2015.

Hilgartner, Stephen, 2000. *Science on Stage: Expert Advice as Public Drama*. Stanford, CA: Stanford University Press.

Horst, Maja, and Mike Michael. 2011. "On the Shoulders of Idiots: Re-thinking Science Communication as 'Event'." *Science as Culture* 20 (3): 283–306.

Igo, Sarah Elizabeth. 2007. *The Averaged American: Surveys, Citizens, and the Making of a Mass Public*. Cambridge, MA: Harvard University Press.

Irwin, Alan. 2001. "Constructing the Scientific Citizen: Science and Democracy in the Biosciences." *Public Understanding of Science* 10 (1): 1–18.

___. 2006. "The Politics of Talk Coming to Terms with the 'New' Scientific Governance." *Social Studies of Science* 36 (2): 299–320.

Irwin, Alan, Torben Elgaard Jensen, and Kevin Jones. 2013. "The Good, the Bad and the Perfect: Criticizing Engagement Practice." *Social Studies of Science* 43 (1): 118–35.

Jalbert, K., and A. J. Kinchy. 2015. "Sense and Influence: Environmental

    Monitoring Tools and the Power of Citizen Science." *Journal of*

    Environmental Policy & Planning. : 1–19.

Jasanoff, Sheila. 1998. "The Eye of Everyman Witnessing DNA in the Simpson

    Trial." *Social Studies of Science* 28 (5–6): 713–40.

___. 2003. "Technologies of Humility: Citizen Participation in Governing

    Science." *Minerva* 41 (3): 223–44.

___, ed. 2004. *States of Knowledge: The Co-production of Science and the Social*

    Order. New York: Routledge.

___. 2005. *Designs on Nature: Science and Democracy in Europe and the United*

    States. Princeton, NJ: Princeton University Press.

Jungnickel, Katrina. 2013. *DiY WiFi: Re-imagining Connectivity*. Basingstoke:

    Palgrave Macmillan.

Kelty, Christopher. 2008. *Two Bits: The Cultural Significance of Free Software*.

    Durham, NC: Duke University Press.

Kraeftner, Berndt, and Judith Kroell. 2005. "What Is a Body / a Person?

    Topography of the Possible." In *Making Things Public: Atmospheres of*

Democracy, edited by Bruno Latour and Peter Weibel, 906–10. Cambridge, MA: MIT Press.

Latour, Bruno. 1982. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press.

Latour, Bruno, and Steve Woolgar. 1979. *Laboratory Life: The Social Construction of Scientific Facts*. Beverly Hills: Sage.

Laurent, Brice. 2009. *Replicating Participatory Devices: The Consensus Conference Confronts Nanotechnology*. CSI Working Papers Series 018. <halshs-00441232>

___. 2011. "Technologies of Democracy: Experiments and Demonstrations." *Science and Engineering Ethics* 17 (4): 649–66.

___. In press. "Political Experiments That Matter. Ordering Democracy from Experimental Sites." *Social Studies of Science*.

Law, John, and John Urry. 2004. "Enacting the Social." *Economy and Society* 33 (3): 390–410.

Law, John, and Evelyn Ruppert. 2013. "The Social Life of Methods: Devices." *Journal of Cultural Economy* 6 (3): 229–40.

Lemov, Rebecca Maura. 2005. *World as Laboratory: Experiments with Mice, Mazes, and Men*. New York: Macmillan.

Lezaun, Javier. 2007. "A Market of Opinions: The Political Epistemology of Focus Groups." *Sociological Review* 55 (s2): 130–51.

___. 2011. "Offshore Democracy: Launch and Landfall of a Socio-Technical Experiment." *Economy and Society* 40 (4): 553–81.

Lezaun, Javier, and Nerea Calvillo. 2014. "In the Political Laboratory: Kurt Lewin's Atmospheres." *Journal of Cultural Economy* 7 (4): 434–57.

Lezaun, Javier, and Linda Soneryd. 2007. "Consulting Citizens: Technologies of Elicitation and the Mobility of Publics." *Public Understanding of Science* 16 (3): 279–97.

Lury, Celia, and Nina Wakeford, eds. 2012. *Inventive Methods: The Happening of the Social*. London: Routledge.

Lynch, Michael. 1985. *Art and Artifact in Laboratory Science: A Study of Shop Work and Shop Talk in a Research Laboratory*. Boston: Routledge and Kegan Paul.

Marres, Noortje. 2005. "No Issue, No Public: Democratic Deficits after the Displacement of Politics." Doctoral Dissertation, University of Amsterdam.

___. 2007. "The issues deserve more credit. Pragmatist contributions to the study of public involvement in controversy. *Social Studies of Science* 37 (5): 759-780.

___. 2009. "Testing Powers of Engagement: Green Living Experiments, the Ontological Turn and the Undoability of Involvement|" in "What Is the Empirical?," edited by Lisa Adkins and Celia Lury, special issue, *European Journal of Social Theory* 12 (1): 117–33.

___. 2012. *Material Participation. Technology, the Environment and Everyday Publics*. Basingstoke: Palgrave Macmillan.

Marres, Noortje, and Javier Lezaun. 2011. "Materials and Devices of the Public: An Introduction." *Economy and Society* 40 (4): 489–509.

Mayer, Andreas. 2013. *Sites of the Unconscious: Hypnosis and the Emergence of the Psychoanalytic Setting*. Chicago: University of Chicago Press.

Michael, Mike. 2009. "Publics Performing Publics: Of PiGs, PiPs and Politics." *Public Understanding of Science* 18 (5): 617–31.

___. 2012. "'What Are We Busy Doing?' Engaging the Idiot." *Science, Technology & Human Values* 37 (5): 528–54.

Miller, Clark. 2004. "Interrogating the Civic Epistemology of American Democracy Stability and Instability in the 2000 US Presidential Election." *Social Studies of Science* 34 (4): 501–30.

Muniesa, F. 2014. *The Provoked Economy: Economic Reality and the Performative Turn*. London: Routledge.

Murphy, M. 2006. *Sick Building Syndrome and the Problem of Uncertainty: Environmental Politics, Technoscience, and Women Workers*. Durham, NC: Duke University Press.

Nold, Christian. 2015. "Micro/Macro Prototyping." *International Journal of Human-Computer Studies* 81 (September): 72–80.

Osborne, Thomas, and Nikolas Rose. 1999. "Do the Social Sciences Create Phenomena? The Example of Public Opinion Research." *British Journal of Sociology* 50 (3): 367–96.

Papadopoulos, Dimitris. 2015. "From Publics to Practitioners: Invention Power and Open Technoscience." *Science as Culture* 24 (1): 108–21.

Petersen, Katrina. 2014. "Producing Space, Tracing Authority: Mapping the 2007 San Diego Wildfires." *Sociological Review* 62 (s1): 91–113.

Plantin, Jean-Christophe. 2015. "The Politics of Mapping Platforms: Participatory Radiation Mapping after the Fukushima Daiichi Disaster." *Media, Culture & Society* 37 (6): 904–21.

Popper, Karl. [1963] (2002). *Conjectures and Refutations: The Growth of Scientific Knowledge*. London: Routledge.

Porter, Theodore. 1996. *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life.* Princeton, NJ: Princeton University Press.

Puig de la Bellacasa, M. 2014. "Encountering Bioinfrastructure: Ecological Struggles and the Sciences of Soil." *Social Epistemology* 28 (1): 26–40.

Reichenbach, Hans. 1938. *Experience and Prediction: An Analysis of the Foundations and the Structure of Knowledge*. Chicago: University of Chicago Press.

Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.

Roberts, Celia. 2006. "Individuality, Somatic. 'What Can I Do to Help Myself?'" *Science Studies* 19 (2): 54–76.

Rogers, Richard. 2010. "Mapping Public Web Space with the Issuecrawler." In *Digital Cognitive Technologies: Epistemology and the Knowledge Economy*, edited by Bernard Reber and Claire Brossaud, 89–99. West Sussex: Wiley-Blackwell.

Rogers, Richard, and Noortje Marres. 2000. "Landscaping Climate Change: A Mapping Technique for Understanding Science and Technology Debates on the World Wide Web." *Public Understanding of Science* 9 (2):141–63.

Rogers-Hayden, Tee, and Nick Pidgeon. 2007. "Moving Engagement 'Upstream'? Nanotechnologies and the Royal Society and Royal Academy of Engineering Inquiry." *Public Understanding of Science* 16 (3): 346–64.

Rosental, Claude. 2013. "Toward a Sociology of Public Demonstrations." *Sociological Theory* 31(4): 343–65.

Sánchez Criado, Thomas, Israel Rodríguez Giralt, and Arianna Mencaroni. 2015. "Care in (Critical) Making: Prototyping as a Radicalisation of Independent-Living." *ALTER. European Journal of Disability Research*. Online first 11 September 2015, http://dx.doi.org/10.1016/j.alter.2015.07.002.

Schick, Lea, and Brit Ross Winthereik. 2013. "Innovating Relations—or Why Smart Grid Is Not Too Complex for the Public," *Science & Technology Studies* 26 (3): 82–102.

Schot, Johan, and Arie Rip. 1997. "The Past and Future of Constructive Technology Assessment." *Technological Forecasting and Social Change* 54 (2): 251–68.

Shapin, Steven. 1988. "The House of Experiment in Seventeenth-Century England." *Isis* 79 (3): 373–404.

___. 1994. *A Social History of Truth: Civility and Science in Seventeenth-Century England*. Chicago: University of Chicago Press.

Shapin, Steven, and Simon Schaffer. 1985. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*. Princeton, NJ: Princeton University Press.

Shapiro, N. 2015. "Attuning to the Chemosphere: Domestic Formaldehyde, Bodily Reasoning, and the Chemical Sublime." *Cultural Anthropology* 30 (3): 368–93.

Soneryd, Linda. 2016. "Technologies of Participation and the Making of Technologized Futures." In *Remaking Participation: Science,*

Environment and Emergent Publics, edited by Jason Chilvers and

Matthew Kearnes, 144–61. London: Routledge.

Stilgoe, Jack. 2007. "The (Co-) Production of Public Uncertainty: UK Scientific

Advice on Mobile Phone Health Risks." *Public Understanding of Science*

16 (1): 45–61.

___. 2015. *Experiment Earth: Responsible Innovation in Geoengineering*.

London: Routledge.

Tironi, Manuel. 2014a. "Atmospheres of Indagation: Disasters and Politics of

Excessiveness." *Sociological Review* 62 (s1): 114–34.

___. 2014b. "Hacia una política atmosférica: Químicos, afectos y cuidado en

Puchuncaví" [Towards Atmospheric Politics: Chemicals, Affects and Care

in Puchuncaví], *Pléyade* 14: 165–89.

___. 2015. "Disastrous Publics: Counter-Enactments in Participatory

Experiments." *Science, Technology & Human Values* 40 (4): 564–87.

Tironi, Manuel, and Nerea Calvillo. 2016. "Water and Air: Excess, Planning and

the Elemental Textility of Urban Cosmopolitics. In *Urban Cosmopolitics:*

Agencements, Assemblies, Atmospheres, edited by Anders Blok and

Ignacio Farías. London: Routledge.

Ureta, Sebastián. 2015. "A Failed Platform: The Citizen Consensus Conference
Travels to Chile." *Public Understanding of Science*, published online
January. doi:10.1177/0963662514561940.

Voß, Jan-Peter. 2016. "Reflexively Engaging with Technologies of Participation:
Constructive Assessment for Public Participation Methods. In *Remaking
Participation: Science, Environment and Emergent Publics*, edited by
Jason Chilvers and Matthew Kearnes, 238–60. London: Routledge.

Voß, Jan-Peter and Nina Amelung. 2016. "Innovating public participation
methods: Technoscientization and reflexive engagement." *Social Studies
of Science*. April 25, 2016 0306312716641350.

Waterton, Claire, and Judith Tsouvalis. 2015. "On the Political Nature of
Cyanobacteria: Intra-active Collective Politics in Loweswater, the English
Lake District." *Environment and Planning D: Society and Space* 33 (3):
477–93.

Whatmore, Sarah, and Catharina Landström. 2011. "Flood Apprentices: An
Exercise in Making Things Public." *Economy and Society* 40 (4): 582–
610.

Wilkie, Alex. 2014. "Prototyping as Event: Designing the Future of Obesity."
Journal of Cultural Economy 7 (4): 476–92.

Wilkie, Alex, Mike Michael, and Matthew Plummer-Fernandez. 2014.

"Speculative Method and Twitter: Bots, Energy and Three Conceptual

Characters." *Sociological Review* 63 (1): 79–101.

Yaneva, Albena. 2013. *Mapping Controversies in Architecture*. London: Ashgate.