Surfacing the Arctic: Politics of Participation in Infrastructuring

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ABSTRACT

The[1] ongoing adoption of sensor networks, algorithms, and digital data comes with the promise of opening up participation in knowledge production. However, the dynamics of the participatory design (PD) processes in these infrastructuring endeavors remain underspecified. This short paper draws on a study of an oil company's project to design an open digital platform to produce knowledge about the Arctic marine environment. Fraught with political controversies, this effort encompasses several stakeholders with contrasting agendas. Leveraging the relational quality of infrastructure, we propose to revitalize the political roots of PD by problematizing simultaneously the roles of human *and* non-human participants, foregrounding both digital technology and the monitored natural ecosystems. We discuss how infrastructuring aimed at letting humans visualize the inaccessible, also shapes participation by creating spaces of (in)visibility and concentrating control over knowledge creation in the hands of the most powerful stakeholders.

CCS CONCEPTS

• Human-centered computing → Participatory design

KEYWORDS

Infrastructuring, politics, participation, relational, environment

ACM Reference format:

Elena Parmiggiani and Helena Karasti. 2018. Surfacing the Arctic: Politics of Participation in Infrastructuring. In *PDC '18: Proceedings of the 15th Participatory Design Conference - Volume 2, August 20-24, 2018, Hasselt and Genk, Belgium.* https://doi.org/10.1145/3210604.3210625

1 INTRODUCTION

Digital infrastructures based on paradigms such as the Internet of Things play an increasingly crucial role in performing relevant information and publics [1]. The active role of algorithms, sensor networks, and data [2] poses challenges to our understanding of the politics of participation, involving not only control and ownership, but also empowerment. From the point of view of participatory design (PD), the idea that participation can and is being shaped by technology is not new [3]. However, the participation of non-human actors, in addition to human ones, deserves to be further problematized in processes of digital transformation. We contend that this represents an untapped opportunity to revive the political roots of PD, to critically examine the politics of participation (cf. Call for Papers for PDC 2016 and 2018), thus "facilitating new forms of politically aware IT development practice and theory by encouraging new ways of drawing on the underlying ideals of PD." [4, p. 88]

The evolving nature of design of infrastructure is captured by the notion of infrastructur*ing*, used to describe infrastructure formation as a process of becoming that stretches across several, emergent dimensions, and human and non-human stakeholder groups [5-8]. Taking the political soul of PD as a starting point, we aim to reflect on the shifting relations among participation, infrastructuring, and politics. We ask: *how can we characterize the politics of participation in infrastructuring processes?* In answering this question, we draw on a *relational* understanding of infrastructure. Infrastructure is instantiated in relation to practice: it means different things to different users in different contexts and emerges when situated practices are afforded by large-scale solutions [9]. Necessarily the work of infrastructuring is political, because it constantly shapes power relations [8, cf. 4]. By following the unfolding of the politics of participation, we take the relational nature of infrastructuring as an analytical lens to scale the political sensitivity of PD into a largely uncharted terrain [7,10].

Our analysis is based on a study of a Scandinavian oil company's adoption of a digital platform as a means to open up access and participation to producing knowledge of the Arctic subsea environment [11]. A difficult to reach, pristine area of the world, the Arctic is estimated to contain approximately 25% of the world's undiscovered oil and natural gas [12]. This case epitomizes a highly debated issue due to the role of Arctic oil and gas activities in both harming the local ecosystems and causing climate change, countered by the technocratic belief that technologies can control our effects on the environment. The politics of Arctic oil highlight in particular the role of sensors, algorithms, and data (that we refer to as digital technologies for short in this paper) as the *only* methods for humans to access unwelcoming marine ecosystems. Whereas this process provides a means for natural ecosystems to participate as a matter of

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PDC'18, August 20–24 2018, Hasselt and Genk, Belgium

https://doi.org/10.1145/3210604.3210625

concern in infrastructuring, it also tends to exclude participants who do not align with the available technological configurations and industrial structures.

2 LITERATURE BACKGROUND

While politics is the soul of PD, its meaning has evolved along with the theoretical sensitivities and the objects of interest of the field. The initial projects conducted in the Scandinavian countries in the 1970s and 80s aimed at applying technologies towards the democratic end of emancipating workers and including their tacit knowledge in innovation processes [13]. For instance, Nygaard's work made clear that empowerment is not awarded by those in power, but something that workers had to acquire through knowledge-based negotiations [13]. PD has also pioneered studies into the way new technologies change work practices, with projects heralded by Xerox, Microsoft, and IBM. As Gartner and Wagner [14] noted, however, the agendas that are made visible in design ultimately tend to reflect existing power and knowledge hierarchies. With the advent of pervasive digital technologies and new global problems, understanding how power and knowledge are inscribed in technological design is increasingly challenging [2]. This reality has triggered a problematization of the notion of participation in the literature, as the practical way in which politics play out in design, e.g., by reconsidering the roles of participant to include non-human actors [3, cf. 15] and broader publics and communities, and by tracing the way their concerns come to matter (or not) in design [16]. Notions such as agonistic design have been proposed to point out that design often requires the establishment of a foundation where conflicts and disagreements are not solved but used productively to align design to different agendas [17].

The expanding of the design object in PD studies has been accompanied by the increasing adoption of information infrastructure and infrastructuring to conceptualize the "social, material, technical, and political changes and formations taking place in our societies." [6, p. 141] Initially, Star and Ruhleder [9] defined infrastructure as a sociotechnical ensemble that emerges in relation to use. To follow the way infrastructure emerges for someone or sinks into the background for others, supporting or hindering their work, is to follow the unfolding of politics. In PD, Neumann and Star [18] made this point discussing the relational quality of participation in design. The meaning of participation and the roles of users (or stakeholders) shift and evolve: that of the user is also a relational concept. What followed from Star's work is a fluid, processual, and emerging ontology [5] of infrastructure formation, which is well described by the concept of infrastructur*ing*. Infrastructuring is thus an inherently political process [6,8,18], "significant in terms of understanding how certain stakeholders in a project may gain leverage or positions of power." [20, p. 252] In this sense, our use of the term 'scaling' in this paper is not intended in its quantified connotation (adding or removing sites or actors), but to focus the attention on the politics involved with it, as different phenomena become relevant in different dimensions (e.g., space, time, use, intervention, inclusions/exclusions, invisibility) for different stakeholders during infrastructuring processes [7,10]. Algorithms too are emerging as significant non-human actors and are indeed an expression of the relational nature of infrastructuring, as they arise in practice and should be understood together with the relation systems that give them meaning [16]. However, the way they come into play remains understudied also in PD.

Reviving Beck's call for tighter engagement with the broader meaning of politics in PD [4], we observe that PD needs to scale also its political sensitivity ("be broader" [4, p. 77]), in the sense of better understanding and challenging patterns of dominance emerging from the design and implementation of digital technologies. We therefore follow the invitation to foreground the relational nature of infrastructuring in PD [19,20] by proposing to go back to the roots of the field [21], as a way to problematize the consequences of digital technologies in the politics of design: who are the users and the stakeholders when 'work' is done by sensors, algorithms, and data? Who is participating? Whose interests followed? [cf. 22]

3 A DIGITAL INFRASTRUCTURE FOR SUBSEA ENVIRONMENTAL MONITORING

This short paper draws on data collected during a three-year ethnographic study (2012-2014) conducted by the first author at a Scandinavian oil company operating in Norway (ScandiaOil, a pseudonym) (refer to [11] for further details). ScandiaOil had just initiated a three-year research and development project (EnviroTime, a pseudonym). EnviroTime sought to design an integrated infrastructure to remotely monitor the risk for the Arctic marine ecosystems during offshore operations in real time over the long term. The envisioned infrastructure relied on a subsea sensor network and quasi-automated algorithms to interpret the marine data and aid environmental advisors working with engineers in halting operations if an ongoing activity – particularly drilling a new well – would cause harm to the marine environment. EnviroTime was entirely industry-driven: it enrolled key players in the Norwegian industrial world, but it did not formally include the environmental organizations, nor the fisheries that are the second largest industrial sector in Norway and interested in better ways of accessing the Arctic waters. Environmental organizations have protested Arctic oil and gas operations, arguing that the operators are not able to preserve the vulnerable ecosystems [23]. However, it is often practically impossible for non-industrial organizations to engage with industrial innovation processes such as EnviroTime, which are driven by industrial goals and technology readiness indicators that are hardly comparable with the modus operandi of the environmental associations. In short, the original setup of EnviroTime worked against the aim to broaden the participation to the process of producing knowledge about the Arctic.

Initially, the ethnography focused on EnviroTime at ScandiaOil, but gradually shifted to investigate the infrastructuring process. The first author conducted participant observations primarily at ScandiaOil's R&D department but focusing also on the partner institutions as they became visible. She obtained 38 interviews with oil and gas professionals, environmental experts, ICT architects, and scientists from ScandiaOil and its partners. In addition, she collected internal documentation, publicly available documentation, statements, and newspaper and magazines articles. The ethnography relied on a combination of scaling mechanisms inspired by existing ethnographic methods to study a process that was distributed and mobile across companies and locations and involved a long-term transformation and many participants and stakeholders [10,24]. For this paper, the two authors jointly analyzed the data retrospectively by paying attention to the dynamics through which the interests of user groups where brought forward or downplayed. Analytically, we performed a gestalt switch, or an infrastructural inversion [6], to shed light on (or surface) the effort that shaped the establishment of infrastructure for real-time environmental monitoring in the Arctic. This effort of foregrounding the background, we recognize, is a political act by the researchers, who also play a role in highlighting some actors' concerns and silencing others [25]. The researcher's work is a relational epistemic process that emerges from the ongoing interactions with the participants over time [7,10,26].

Norway is one of the so-called petro-states facing the Arctic region, sharing its eastern border in the Barents Sea with Russia. In the 2000s, the accessibility of that area was increasingly enabled by the installation of subsea sensor networks, fiber-optic subsea data-transfer cables, and standardized remote collaborative systems, aimed to achieve safer and more efficient operations in harsh weather conditions [27]. Regulatory agencies began focusing on a continuous and integrated approach to the monitoring of the marine natural environment [28], as opposed to sporadic risk assessment rounds based on sampling and lab analysis, with temporal gaps of about one year. ScandiaOil's EnviroTime integrated real-time method thus promised to help environmental advisors identify threats during day-to-day operations. EnviroTime focused particularly on commercially relevant fish species such as cod and mackerel. However, the development of the algorithm for fish risk assessment faced delays, because fish monitoring proved technically cumbersome. The most important sensors to detect fish were the echo sounders – which send an acoustic signal and measure the echo returned by any obstacle that interrupts the signal. Fish can be one such obstacle, but the algorithms to interpret the data sent onshore by the off-the-shelf models of echo sounders used in EnviroTime could only interpret the louder echoes, namely those returned by fish endowed with a swim bladder, a bladder filled with air that allows the fish to float and swim. Mackerel, originally envisioned as a target, do not have such a swim bladder and were therefore ignored by the project. ScandiaOil researchers involved in EnviroTime then obtained additional funding from the company's production department to solve this problem. These funds were useful for a group of ScandiaOil's IT experts and environmental advisors to initiate a smaller, under-the-radar, and relatively independent initiative (dubbed Skunkworks) to test approaches for real-time subsea risk assessment, away from the complexity of EnviroTime.

A new sensor network, similar to the EnviroTime one, was deployed above the Arctic circle, off the coast of northern Norway, in an area where oil and gas operations are forbidden. Because this was a non-operational area, the Skunkworks initiative did not need to respond to industrial innovation parameters or follow formal decision gates. The process of enrolling external partners with direct experience of the marine environment was thus more open, and included an independent institution conducting marine research, a small startup company with expertise in subsea sensor networks, and, although not formally, groups of local fishermen. Another element of difference in this case was the data management and visualization part of the project. A fiber-optic cable was installed in cooperation with a group of fishermen, who rented out their boats and helped at an affordable price. The collected environmental data was to be sent to a small onshore data center. Data would be polished and standardized according to open international data sharing standards and published in real time on a web portal. The Skunkworks web portal included intuitive graphics such as the visualizations of water parameters, pictures of the surrounding flora and fauna, and colorful graphs displaying fish concentration at different water depths over time based on the acoustic data gathered with the echo sounders. Anyone could download datasets from the web portal and use them, given ScandiaOil's intention to develop methods and apps for improving real-time environmental risk assessment.

The Skunkworks web portal was presented to the fishermen groups of northern Norway as something useful to them and was reported by the local newspapers as a great success. On the portal home page, acknowledgements were made to all the Skunkworks project partners, minus the fishermen despite their situated experience of the marine environment. Their enrollment also mirrored the long-lasting, love-hate relationship between the two key industrial players in Norway. Although competing for the same resources and territory, they display an (informal) will to cooperate to improve efficiency and safety to operate in the Arctic [29]. More open and inclusive, the Skunkworks project was nevertheless an offshoot of an industrial project. By adopting a sensor network like the one in EnviroTime, it relied on the same assumptions about what was relevant to track. Moreover, despite the initial success, the web portal soon presented a surprise to ScandiaOil. A few weeks after it went online, the IT experts detected unrecognized traffic flows. Upon closer investigation, they discovered that the irregular traffic consisted of foreign hackers who were trying to download the datasets. According to our informants, the interest of the hackers was due to reasons of international geopolitics: among the obstacles visible to the echo sounders were ships, boats, and U-boats used by the navy fleets exercising in the surroundings. Ships and boats have a unique acoustic signature, thus making it easy for hackers to map their position at sea. The Skunkworks project managers thus responded by publishing the environmental data online with an arbitrary delay of a few hours, making them less relevant to the hackers' purposes.

4 POLITICS OF PARTICIPATION

A statement by a representative of the US Bureau of Safety and Environmental Enforcement astutely summarizes what the relational quality of the Arctic marine infrastructure means in practice: "*There is no single Arctic*." [30] This is due to the variations of the natural environment across the region, international politics, and economic and socio-cultural aspects. By the same token, new systems that allow humans to access the Arctic subsea are all driven by different conceptions and interests in what counts as 'Arctic'. The Arctic underwater environment is perceived in different ways over time based on how (digital) technologies (can) represent it: as harsh and inaccessible to humans, as (partially) accessible via real-time connections, as a source of fossil resources to extract, and later as the source of hacker threats. We propose a few initial answers to our research question that future research might extend to scale up the innate political sensitivity of PD, by problematizing the role of participation in infrastructuring processes.

First, digital technologies participate in the sense that they influence who counts as a 'user': they not only enable but also modulate the participation of specific user groups. For instance, in the beginning of the EnviroTime project, the notion of user was only vaguely identified with the environmental advisors, but it gradually changed as relations were established (or not) through the infrastructuring process. Digital technologies created a space for the cooperation between competing (human) user groups, where (industrial) interests could purposefully co-exist despite different goals [16]. This was a case where ScandiaOil and the fishermen groups, both were interested in developing better techniques to operate in the Arctic [cf. 31]. Thus, user groups emerge (or not) not in a serendipitous way, but as the design process becomes accessible to and shared with them on some level, for example, when the Skunkworks web portal was introduced to the fishermen based on technologies that they also regularly use (the echo sounders) to track fish species of interest and on algorithms that packaged the measurements in a format that was relevant to them. Antagonism between the fishermen and the oil company was channeled into producing new knowledge about the marine environment, whose relevance might evolve over time. The work within an ecology of practices does not strive towards consensus, but typically towards symbiotic agreement, where symbiosis is understood as a state in which every protagonist is interested in the success of the other for their own reasons [32, p. 35]. Infrastructure design is therefore emergent, as "[i]ntervening not only happens through intentional acts, but also is the result of the connecting and layering of infrastructures over time as they expand into different arenas and contexts" [7, p. 240]. ScandiaOil's construction of a platform that did not include oil and gas-related data led to a pluralism of participation that manifested itself in a productive way – but was only open to those stakeholders able to align with industry-driven innovation processes (hence not environmentalists).

Second, digital technologies also create a political space of the Arctic subsea, one that includes the (measurable) natural ecosystems. Real-time data transfer and algorithms which provide automatically updated models change the perception of the marine environment from far away to here and now. However, in so doing, they are also enacting spaces of inclusion and residual categories [33] according to both their characteristics and the narratives they are made to fit into [cf. 34]. As the undifferentiated marine environment is turned into quantified, measurable parameters, the (invisible) algorithms contribute to shaping the generated data and in determining what is relevant thus visible, and what is invisible thus irrelevant for specific audiences [33, cf. 2]. For instance, the algorithms developed by ScandiaOil and its partners were strictly focused on detecting commercially relevant species. The combination of these algorithms and the echo sounders used to interpret the acoustic data in EnviroTime caused the fish without a swim bladder to go unnoticed, therefore excluded. Marine mammals were also excluded in the design process, despite the protests of the environmental activists that the acoustic technologies used by oil companies cause high distress for them [35]. This tendency to focus on commercial species such as cod was reinforced through the Skunkworks project that was successful in enrolling the fishermen interest groups in ScandiaOil's initiative. In an age where everything seems to be visible and accessible all the time, there are (new) categories that do not fit into the emergent narratives – i.e., that are not translated into digital datasets – and thus become invisible and unaccounted for [33]. Nevertheless, although digital technologies certainly objectify and, to a large extent, silence nature as they stand in for it [cf. 15], they often provide us with the (only) means to include nature as a participant, at least as a matter of concern to be considered here and now.

Finally, our case illustrates the participation of digital data in infrastructuring in a rather surprising way. Military vessels were an unexpected, residual category that emerged from Arctic datasets as it attracted the attention of hackers. To conclude, digital technologies which shape participation are largely invisible, yet they both depend on knowledge of nature and create knowledge themselves. The business-centered orientation of the EnviroTime infrastructure ultimately constrained the way knowledge was valued, e.g., by not explicitly acknowledging the fishermen but considering commercial fish species. This is telling of the tendency of digital technology being used to make participation in knowledge creation *invisible*, rather than visible. Although digital technologies promise better and faster access to information, they tend to mirror established concentrations of power [cf. 4]. Our case highlights that power does not only imply more surveillance, but also control over the methods to create knowledge and shape phenomena.

ACKNOWLEDGMENTS

This work is supported by the project MULTICS "Multi-scoped infrastructuring", funded by the Academy of Finland (#285903) and the project "Digital Oil" (#213115) and the Center for Integrated Operations in the Oil and Gas Industry", funded by the Norwegian Research Council.

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