Introduction
Infrastructure

Janet Vertesi

The study of infrastructural systems, their assumptions, and their exclusions has been a staple of science and technology studies for over 20 years. Foundational work in the 1980s and 1990s by the late Susan Leigh Star set the scene for how to examine these otherwise submerged systems (Star and Ruhleder 1996; Star 1999). This work brought historian Thomas Hughes's work on sociotechnical systems into new terrain (Hughes 1983), with especial attention to how such large-scale, ubiquitous, and submerged systems could be productively analyzed as sites of contestation, of practice, and of power. Geof Bowker's concept of the "infrastructural inversion" (Bowker 1994) and later their coauthored book *Sorting Things Out* (Bowker and Star 1999) demonstrated this analytical technique for a new generation of STS scholars already well versed in the politics of technology and actor-network theory.

In many ways, the study of infrastructure is a perfect starting point for analyzing aspects of the Internet and digital technologies, which rely upon a sprawling, networked backbone of hardware, software, and invisible technicians. This sense that infrastructure must matter to digital systems is itself a product of the intellectual and institutional overlaps between Star and her colleagues, based in computer science departments and information schools in the United States in the 1990s. From this location, infrastructural scholars continue to speak frequently and clearly alongside system designers and builders, contributing to computer science conferences like computer-supported cooperative work (CSCW) and establishing parameters for design (for more on this history, see Vertesi et al. 2016). The recent success of "cyberinfrastructure" studies in STS and in CSCW speaks to this enduring crossover among generations of Bowker and Star's students (see, for instance, Bietz and Lee 2009; Ribes 2014; Ribes and Finholt 2009; Jackson et al. 2011; Millerand and Baker 2010). Given the extant influence of such theories and framings in existing studies of Internet technologies, it is no surprise that many chapters in this volume draw on this STS concern with infrastructure and its discontents.

The chapters in this section all address infrastructural systems in different ways, participating in sustained STS attention to the often-invisible sociotechnical systems that influence scientific and daily life. Since tracing the enormity of cyber-systems is a difficult task, they instead attend to points of encounter and practice wherein individuals confront, contest, or otherwise deploy networked systems. For instance, seeking to move from discussing infrastructure to understanding

infrastructures in use, Sawyer and colleagues advance the concept of "infrastructural competency." They examine how mobile workers such as real estate agents and architects must develop fluency with multiple infrastructural nodes, materials, hardware, and software systems in order to achieve their very mobility. Competency is locally performed as a "goal-oriented practice" as individuals thread together text messages, mobile Internet access, car seat file cabinets, even portable fax machines to produce seamless client interactions and accomplish their work. Centered in infrastructural studies, this essay speaks eloquently from the continuing, fruitful dialog between STS and CSCW at the information schools.

In contrast to instances of infrastructural competence, Singh et al.'s chapter on GPS systems in use focuses on instances of problem solving, getting lost, and situational repair. The authors examine how individuals manage digital "instructed actions" as practical, situated achievement. This draws on a different yet synergistic stream of analysis in science studies from that of infrastructures: ethnomethodology (Garfinkel 1967). The authors use this approach, advanced in STS by scholars like Lucy Suchman and Michael Lynch (Suchman 2006; Lynch 1991), to demonstrate how digital media "reconfigure" the relationship between maps and journeys through the simple use of a GPS-enabled smartphone.

These examples treat everyday digital systems, but what of systems in the sciences and industry? Addressing the "politics of digital infrastructure," Parmiggiani and Monteiro analyze a Norwegian web portal designed to carefully balance various stakeholder needs and identities in an oil-drilling region. Situated amid environmental advocates, scientists, and the NorthOil company, the "in-the-making" status of the web portal–cum–sensor network keeps the status of debates about climate change, science, and business interests open to enable conversation between constitutive groups. Doris Allhutter, like Singh et al., departs from the classic infrastructural lens, deploying the analytical framework of ontologies in her case. Examining a computational system that itself categorizes computational ontologies, Allhutter uses changes in the sociotechnical system to show how system engineers perform ontological work in the world, then deftly uses the example to speak back to STS theorizing about ontology itself (i.e., Mol 2002; Thompson 2007; Woolgar and Lezaun 2013).

Analyzing infrastructures in case studies is one way to understand their power and potency for sense making, sensing and confronting them in the wild is another. In their "techno-imaginative setup" of the Energy Walk, Winthereik and colleagues explore the "imaginative dimensions of infrastructures" by building and installing a digital system that guides individuals on a walking tour through a northern Danish village. They describe the system as an emergent infrastructure "for making relations within and between" elements of the environment, its publics, and the researchers themselves. As a result of this makerly approach, the authors suggest that STS scholars and practitioners come to view digital systems as "unruly research participants" in their sites. With such a range of theoretical and practical ways of attending to this classic topic in science and technology studies, as well as a wide range of contemporary examples, these chapters on infrastructure offer productive pathways for STS scholars wherever their theoretical and empirical sympathies may lie.

Works Cited

Bietz, Matthew J., and Charlotte P. Lee. 2009. "Collaboration in Metagenomics: Sequence Databases and the Organization of Scientific Work." In *Proceedings of the 11th European Conference on Computer Supported Cooperative Work, 7–11 September 2009, Vienna, Austria*, 243–62. London: Springer.

Bowker, Geoffrey C. 1994. *Science on the Run: Information Management and Industrial Geophysics at Schlumberger, 1920–1940*. Inside Technology. Cambridge, MA: MIT Press.

Bowker, Geoffrey C., and Susan Leigh Star. 1999. *Sorting Things Out: Classification and Its Consequences*. Cambridge, MA: MIT Press.

Garfinkel, Harold. 1967. *Studies in Ethnomethodology*. Englewood Cliffs, NJ: Prentice Hall.

Hughes, Thomas Parke. 1983. *Networks of Power: Electrification in Western Society, 1880–1930*. Baltimore: Johns Hopkins University Press.

Jackson, Steven, David Ribes, Ayse Buyuktur, and Geoffrey Bowker. 2011. "Collaborative Rhythm: Temporal Dissonance and Alignment in Collaborative Scientific Work. In *Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work*, 245–54. New York: ACM.

Lynch, Michael. 1991. "Laboratory Space and the Technological Complex: An Investigation of Topical Contextures." *Science in Context* 4 (1): 51–78.

Millerand, Florence, and Karen S. Baker. 2010. "Who Are the Users? Who Are the Developers? Webs of Users and Developers in the Development Process of a Technical Standard." *Information Systems Journal* 20 (2): 137–61. doi:10.1111/j.1365-2575.2009.00338.x.

Mol, Annemarie. 2002. *The Body Multiple: Ontology in Medical Practice*. Durham, NC: Duke University Press.

Ribes, David. 2014. "Ethnography of Scaling; or, How to a Fit a National Research Infrastructure in the Room." In *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing*, 158–70. New York: ACM. doi:10.1145/2531602.2531624.

Ribes, David, and Thomas A. Finholt. 2009. "The Long Now of Technology Infrastructure: Articulating Tensions in Development." *Journal of the Association for Information Systems* 10 (5): 375–98.

Star, Susan Leigh. 1999. "The Ethnography of Infrastructure." *American Behavioral Scientist* 43 (3): 377–91. doi:10.1177/00027649921955326.

Star, Susan Leigh, and Karen Ruhleder. 1996. "Steps toward an Ecology of Infrastructure: Design and Access for Large Information Spaces." *Information Systems Research* 7 (1): 111–34.

Suchman, Lucy. 2006. *Human–Machine Reconfigurations: Plans and Situated Actions*. 2nd ed. Cambridge: Cambridge University Press.

Thompson, Charis. 2007. *Making Parents: The Ontological Choreography of Reproductive Technologies*. Cambridge, MA: MIT Press.

Vertesi, Janet, David Ribes, Laura Forlano, Yanni A. Loukissas, and Marisa Cohn. 2016. "Engaging, Making, and Designing Digital Systems." In *Handbook of Science and Technology Studies*, 4th ed., edited by Ulrike Felt, Rayvon Fouché, Clark A. Miller, and Laurel Smith-Doerr, 169–94. Cambridge, MA: MIT Press.

Woolgar, Steve, and Javier Lezaun. 2013. "The Wrong Bin Bag: A Turn to Ontology in Science and Technology Studies?" *Social Studies of Science* 43 (3): 321–40. doi:10.1177/0306312713488820.