Infrastructuring as Appropriating in the Context of Mobile Knowledge Work

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Abstract
Highly mobile knowledge workers spend a large portion of their time traversing within and among different infrastructural configurations as they move through space. These dynamic configurations are experienced as either technological or contextual constraints, which range from forms of technological exclusion and infrastructural disconnection to divides caused by both spatial and organizational boundaries. The workaday nature of these constrained environments force mobile workers to engage in a type of articulation work that involves the construction of bridging, assembling, or circumventing solutions to repeatedly negotiate these impediments. Engaging in these 'infrastructuring' practices requires that workers develop 'infrastructural competence'—knowledge of the generative possibilities of infrastructural seams. In effect, this renders mobile workers as infrastructural bricoleurs. We discuss the implications of this required competence and speculate regarding its origin, maintenance, and differentiation among professions.

Author Keywords
Infrastructuring; infrastructural seams; appropriating

ACM Classification Keywords
Organizational Impacts, Computer-supported collaborative work.

Related Work

It is no longer notable to claim that a vast majority of work practices are mediated by information and communication technologies, but what is less fully explored in the discourses of work and technology is the physical dynamism of modern work. By virtue of mobile technologies and infrastructures, today's workers—like professional satellites—execute their work by orbiting around clients, co-workers, and infrastructures across expanded temporal and spatial zones to accomplish tasks that were once characterized by a networked computer on a personal desk in fixed office building, typically between 9am and 5pm [3; 4].

Previous research has partially explored this uptick in the dynamic nature of work, noting the way that workers mirror 'nomadic' practices [2; 19] such as traveling long distances, working without stable workplaces or fixed organizational anchors, and managing and carrying resources while on the move [5; 16]. Of these insights, one particularly important strand is the contention that the increased dynamism of work via physical mobility introduces infrastructural challenges for workers. As Su and Mark [19] suggest, mobility puts 'nomadic workers' into a persistently visible and active relationship with information infrastructural arrangements because the likelihood of a breakdown, either in workflow (i.e., social) or technological connectivity, is heightened by the continuous encounter with barriers and boundaries as he or she moves. In short, to be mobile is to be engaged in a constantly changing relationship to infrastructure. Because different infrastructures are typically less than ideally, if at all, integrated with one another, workers must constantly focus their attention on identifying, managing, and working through or across infrastructural gaps and disconnects [6]. Mobility, in this sense, is synonymous with a lack of access to centrally organized resource-allocation mechanisms (prevalent in stationary forms of work) and a concomitant requirement to navigate multiple installed bases of situated infrastructures, nearly all of which are organized independently.

Knowledge workers' increased dynamism is made possible by a combination of expanded ICT networks, the development and adoption of mobile device systems designed to support enterprise tasks, and the social evolution of mobility as an integral, if not normative, component of both individual and organizational identity [13]. This set of sociotechnical arrangements comprises what we consider a knowledge infrastructure, albeit one that is less massive in scale than most cyberinfrastructure projects that support—typically—new knowledge production in the sciences [8]. Infrastructure, as so derived, is highly relational, wedding human habits and technological contexts of adoption/adaptation together [15]. An infrastructure takes shape as a collection of technological systems, devices, and interfaces, but it also comprises people's relationships with and around these artifacts, including the human habits, norms, politics, standards, and temporal rhythms and roles that often prove to be its most immutable elements [8]. At once assembled and relational, infrastructure, as Star and Ruhleder [18] also note, is usually transparent and invisible when it is functioning properly. To experience infrastructure knowingly, it has often been said, is to experience it when it is not working. This framing of infrastructure aligns with Weiser's original conception of ubiquitous computing [21], in which users were envisioned to move across a space without technological breakdown

or disruption—in other words, 'seamlessly'. For Weiser, seams, or recognized gaps or points of breakdown, represented a failure on the part of infrastructure designers because they force users to become cognizant of the design and limitations of the environment at hand.

Recent infrastructure studies scholarship presents a different take on infrastructural seams, however. Knowledge infrastructures are now described as comprising multiple, heterogeneous sub-infrastructures that have been grafted [17] or merged [14] together to achieve a particular professional or scientific end. Infrastructures grow in an evolutionary manner, beginning as a primary installed base [7] and morphing across time with the introduction of new participants and tasks to accommodate additional features, capabilities and arrangements. Today this 'assembled' or seamful quality of infrastructure is affirmed as potentially more empowering than Weiser's frictionless surround, as Dourish and Bell [7, p. 29] acknowledge, "…<seeing> infrastructure as stable, uniform, seamless, and universally available is clearly problematic."

Seams, in addition to outlining a more accurate understanding of the technical configuration of an infrastructure, also impart insight into our relations with it. Vertesi [20], for example, claims that seams, while not necessarily welcome, are opportunities for actors to bridge infrastructural gaps 'artfully', to perform infrastructural workarounds that accord with the sociotechnical relationship(s) present at any one seam's edge. In this way, brokering and bridging seams perpetuates the need for continued personalization or customization in the way(s) that an infrastructure is managed and used in situ. As a whole, these acts of infrastructural alignment and navigation are called 'infrastructuring' [1; 9; 10; 12]. This literature documents the way that actors make sense of heterogeneous infrastructures and, in response, construct—either individually or collectively—a bricolage of material, mental, social, and cultural resources to adapt to seamful situations and advance accordingly. Infrastructuring can often be seen in response to an infrastructural impediment like an unruly or incompatible seam between infrastructures or at a moment of infrastructural breakdown [15]. These sites of engagement are particularly appealing for analysis because they illuminate the dependencies among the comprised components or the lack thereof [11].

Our Research

Our research identifies two meta forms of constraint—technological and contextual—that workers encounter in their mobile, dynamic relationships to infrastructure. Technological constraints are those primarily rooted in the material properties of technologies, which we further identify as having two experiential outcomes: (1) technological exclusion, or the disconnect among multiple (competing) infrastructures, and (2) infrastructural disconnect, or the need to negotiate an infrastructure's visible edges, endings and exclusions. In parallel to technological constraints, we also note contextual constraints, which are experienced when either spatial or organizational boundaries are present.

We explored the effects of these varying constraints with a set of 43 mobile knowledge workers in New York City and Research Triangle Park, North Carolina. Our analysis confirms that technological and contextual

constraints pervade the daily working environments of mobile knowledge workers. More importantly, however, we also see that these workers engage in a series of strategic infrastructuring practices that help them right or remedy the technological, geographic, and organizational challenges that regularly confront them.

Using a practice lens, we identified three primary patterns regarding these practices: bridging, assembling, and circumventing. Bridging is an infrastructuring practice in which workers attempt to bridge incompatible digital infrastructures (e.g., brand ecologies) by introducing some form of aligning intervention. This work is necessary whenever there is an infrastructural disconnect or when organizational constraints impede the ready construction of a desired infrastructural configuration. Workers also engage in the even more creative practice of 'assembling' technologies to fashion working infrastructural solutions anchored to the task at hand, such as maintaining a network connection or extending a power supply while on the go. Finally, workers actively circumvent constraints by improvising workarounds that take advantage of functionally equivalent technologies or technological processes. Each of these practices enables workers to 'artfully' deal with infrastructural seams and present the necessary semblance of seamlessness to maintain an adequate professional identity, rhythm and/or interaction profile.

Extended reflection highlights requisite knowledge needed for workers to act as infrastructural bricoleurs. Drawing on the notion of literacy, we refer to this actionable infrastructural knowledge as infrastructural competence [6]. To have infrastructural competence is to be able to recognize where infrastructural seams may have generative, rather than exclusionary, properties and to draw upon this sociotechnical insight to appropriate already existing infrastructures through certain infrastructuring practice. Notably, our interviewees frequently report that proprietary seams hinder their ability to integrate multiple brand-based platforms, applications, and devices. Often these ecosystem exclusivities (e.g. Microsoft vs. Apple) bury the ability to detect generative seams by automating integration (e.g., Google or Apple automatically backing up data into their own cloud storage service: Google Drive or iCloud). Ironically, this designed 'seamlessness' a la Weiser puts workers in the position not only of bridging, assembling or circumventing when necessary, but also—increasingly—of detect potential seams (aka, sites of intervention) in the first place.

A current agenda for our research involves understanding how infrastructural competence is developed and sustained collectively. Practice as the level of analysis is a collective achievement and involves insight and actions from multiple actors. The ways our participants enact infrastructuring practices are shaped by collaboration with business partners and clients. For example, collaborating with multiple clients requires bringing together various cloud-based platforms to satisfy different needs of different clients. Interestingly, there may also be a move—seen often in the context of smaller, startup organizations—to leverage proprietary ecosystems to their full advantage for reasons less driven by task goals and more by client aims or preferences (e.g., conducting all work within Google Drive). In our studies to date, this choice appears no less strategic than the other types of appropriation work, typically expressing core sociotechnical insights as to how relationships can best

be managed through specific infrastructural configurations.

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