EGOS 2014 Subtheme 52: Mobile Work, Technology, and Issues of Control

MORE THAN NOMADS: MOBILITY, KNOWLEDGE WORK, AND INFRASTRUCTURE

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Introduction

It is well documented, and indeed well-discussed (e.g., Jarrahi & Sawyer, 2013; M. Mazmanian, Orlikowski, & Yates, 2013), that work in our current era is has shifted and changed due to the introduction of information and communication technologies (ICTs). At the same time, economic forces such as the Great Recession and the expansion of the global economy have helped to create models in which work has become more modular and project-based (Barley & Kunda, 2006; Herbsleb, 2007; U. Schultze & Boland, 2000). Combined, these sociotechnical forces have led us to a point where we can now equate many of today's workers with satellites—actors who define their work not by their presence in a traditional work-related location but by their agile ability to orbit around clients, co-workers, and infrastructures, integrating inputs and output as they circumnavigate (Costas, 2013; Czarniawska, 2011; Jones, 2013). We define these individuals herein as *mobile knowledge workers.*

In general terms, knowledge workers constitute a fast-rising population in contemporary society; the so-called 'creative class' of workers in America (Florida, 2002), for example, has doubled in just one generation, rising from 22 percent in 1960 to 43 percent in 2006 (Rainie & Wellman, 2012). This rise, which extends worldwide (e.g., Liegl, 2014), has been largely attributed to the aforementioned economic forces, which have changed work structures. Work has shifted away from growing, making, and transporting goods toward selling, describing, and dissecting goods via words and images. Rainie and Wellman (2012, p.173) have coined this shift one of moving away from "atom" work, the processing of large-scale physical items, toward "bit" work, the creation and manipulation

of large quantities of digital data. The phrase "bit" work is a convenient neologism that captures and portrays the nature of contemporary knowledge work, its all-important untethered, free-floating, 'mobile' affordances, and its commonly digital character.

Herein we promote a nascent definition of mobile knowledge work in line with this 'bit' characterization. As such we understand mobile knowledge workers as primarily engaged in work for which they have singular expertise. It is this expertise that drives demand for the participation of specific individuals, which typically requires greater than episodic travel. Most importantly, is the insight that the specialist, mobile activities of these workers require the regularly navigation of a set of boundaries—temporal, spatial, organizational, infrastructural, social, and cultural—in order to accomplish work successfully. These three facets of work—its bit-related, knowledge composition; its requisite mobility; and its infrastructural engagement—begin to draw out a conceptual area—a triad, of sorts—that we can use to interrogate the empirical realities of mobile knowledge workers in the future. To begin laying this groundwork, we first look to the literatures on knowledge work, mobility, and infrastructure studies individually. We follow this with a discussion of emergent themes that starts to showcase generative relations between and among the three dimensions. Finally, we conclude with a set of research questions that we hope will provoke additional research in this area, including our future study of mobile knowledge work practices in the U.S. states of New York and North Carolina.

Three Discourses: Knowledge Work, Mobility, and Infrastructure Studies

A study of mobile knowledge work is simultaneously a study of knowledge work, mobility and infrastructure. This reflects the fact that many mobile knowledge workers are members of the 'knowledge economy'; their work is more than likely to be the provision of a professional service (such as consulting or technology development) than an activity anchored to a particular location for need of specific equipment or tools. Mobile knowledge workers are also, as described, mobile. Their work requires them to travel more than episodically, whether it be to visit clients, visit remote sites, or engage in other forms of relocated collaboration. This high mobility lends these workers to avail themselves of mobile tools and services more than might be the case with other workers. Finally,mobile knowledge workers' professional success appears to require a sophisticated social and technical acumen that allows these workers to efficiently and accurately leverage a host of

different digital infrastructures simultaneously. This skill set is based on mobile knowledge workers' understanding of the availability, uses, and potential of technological systems and their relationship to organizational, temporal, and spatial boundaries.

It is clear that these three dimensions of mobile knowledge work are deeply entwined; extracting any one for discussion as a singular element risks creating distinctions that are inaccurately tidy. However, it is also clear that each of these areas has been discussed independently in literature on work, technology, and organization. In acknowledgement of this lineage, we highlight each area in turn while also paying particular attention to the connections between discourses, themes and descriptive details.

Knowledge Work

Using a multitude of terminologies, scholars from the likes of organizational science, knowledge management, and information systems have developed a definition of knowledge work that includes: 1) the production and transmission of knowledge, 2) intellectual skill and manipulation of abstractions, 3) problem solving tied to creativity, and 4) theoretical and technical knowledge and/or formal education (Creplet, Dupouet, Kern, Mehmanpazir, & Munier, 2001; Davis, 2002; Ulrike. Schultze, 2000). This aggregative description suggests that knowledge work is an inherently cognitive (as opposed to physical) type of labor that typically generates information or knowledge as its primary output.

One of the most prominent themes to arise from the above characterization is the distinction that knowledge work necessitates particular "human mental work" (Davis, 2002). This assessment is used to set apart knowledge professions from other professional areas; in contrast to more bounded, clerical vocations, knowledge work is understood to be unpredictable, leading workers to continuously handle issues in a 'non-routine' way. The cognitive demands of this style of work mean that knowledge workers often acquire specialist skills in problem identification and problem solving, as well as tacit sensibilities that allow them to deftly engage in convergent, divergent, and creative thinking (e.g., Drucker, 1993; Reich, 2010; Reinhardt, Schmidt, Sloep, & Drachsler, 2011). As such, prototypical knowledge workers have come to be identified with analytically driven professions in such fields as mathematics, economics, engineering, science, psychology, law, and consultancy as well as more creatively-oriented areas in architecture, design, academe, art, music, and entertainment (e.g., de Carvalho, Ciolfi, & Gray, 2011; Florida, 2002; Rainie & Wellman, 2012). These fields identifiably involve taking concepts, problems, and ideas and integrating them—often with and through others—in order to

create knowledge products, such as designs, reports, computer code, diagnoses, policies, rules, plans, summaries, and analyses.

The conceptual quality of knowledge work concomitantly demands a significant degree of autonomy (Creplet et al., 2001), a fact that has led knowledge workers to be dubbed "gold collars" (in contrast to blue or white collar workers). In turn, however, this autonomy puts pressure on knowledge workers to know what must be done in order to maintain one's intellectual status—for example, reading literature, attending meetings, or exploiting new systems (Davis, 2002; Harmer & Pauleen, 2012). Autonomy means that knowledge workers must also invest in their own information management (e.g., Teevan, Jones, & Bederson, 2006) given that they are often without the traditional support structures for records management and staff for administration that are found in traditional offices.

Notably, it is exactly this autonomous and intellectual nature of knowledge work—in other words, its internal and individual dimensions— that lends itself well to technological mediation. For virtue of their relatively high levels of independence, many knowledge workers can now work apart from conventional corporate structures (Cortada, 1998; Harmer & Pauleen, 2012; Kelley, 1985). The inputs required to perform within knowledge professions do not depend on place- or site-specific resources or functions and are not constrained to specific locations or times. Instead, knowledge work is tied to individuals, meaning that many forms of knowledge practice are carried out by employees working away from centralized organizations in a distributed or mobile modality (e.g., Davis, 2002; Koehne, Shih, & Olson, 2012; Olson & Olson, 2014). These characteristics of knowledge work signify the ever-increasing relationship between knowledge-intensive work practices and the possibility of mobile work (conducting work from anywhere at any time).

In sum, we can highlight four important changes overtaking contemporary work, the confluence of which makes knowledge work, in particular, an appealing area for study. First, with the expense of highly specialized, knowledge-intensive expertise, workers are often more oriented to disparate projects than to stable work. This affects not only the work they do, but also the mobility the experience while doing it. Second, with work becoming increasingly contractual, project-driven, and skill-based, individual workers act like independent agents or companies in and of themselves. Their employing organizations (presuming they even have external organizational affiliation(s)) take on roles similar to that of talent manager. Mobile knowledge workers may not have a singular organizational affiliation, or their affiliation may be their own consultancy. In such cases, they must be a

bricoleur of work, their mobility necessary so that they may stitch their occupational patchworks into a whole. Third, an increasing range and suite of digital technologies and devices both reflect and shape these trends, presenting mobility as a 'norm' and work and technology as inseparable. Fourth, the inextricability of work from technology and the mobile affordances of this technology lead to a blurring of personal and professional so commonplace it easily drops into the realm of the obvious. We move to sharpening our understanding of the mobility issues of mobile knowledge work in the following section.

Mobility

Mobility, both in relation to knowledge work and otherwise, has also been extensively researched in recent decades (e.g., Ciolfi & de Carvalho, 2014; Ling & Donner, 2013; Sørensen, 2011). Sociological discussions of mobility, for instance, furnish a significant theoretical perspective on both the obligations and opportunities geographic movement affords (Urry, 2000, 2013) suggesting that many of us are now "orchestrating new forms of social life around [certain] nodes, for example, stations, hotels, motorways, resorts, airports, leisure complexes, cosmopolitan cities, beaches, galleries, and roadside parks" (Sheller & Urry, 2006, p. 213). Alternately, scholarship related to mobile work practices and professions—largely within management studies—has mainly focused on concepts such as temporary work and nomadic work, investigating how well-defined understandings of space, time, context, and traditional organizational norms and structures are being upended for new, more flexible arrangements variously instantiated across telecommuting, home-working, co-working, shared offices, hot-desking, and mobile working forms. Given our focus on work in this paper, we develop the later area of research more extensively herein than the former.

Yet in making this scoping decision, we also acknowledge that the current terminology surrounding mobility and work (sometimes, but certainly not always referred to as 'mobile work') is complicated as much of it is nascent and at times inconsistent. The following discussion of mobility and mobile work signifies one attempt to synthesize several strands of related research still very much in their formative stages.

To date, the concepts of 'mobile work' and 'nomadic work' are the most predominantly highlighted in various salient literatures that address this empirical area. In general terms, *mobile* workers are defined as those workers who extend and expand the places and spaces in which they conduct their work, encompassing locations beyond the traditional organizational nucleus (Middleton, 2008). References to the *nomadic* workforce,

by contrast, are made with a broader scope yielding the following distinction: "*a mobile worker is always a nomadic worker, but a nomadic worker is not necessarily a mobile worker*" (Chen & Nath, 2008, pp. 59-60, original emphasis) . Nomadic workers "are characterized by a higher level of mobility or greater distance from the traditional office, or both" (Chen & Nath, 2008, p. 60) than are mobile workers; indeed, some researchers (e.g., Czarniawska, 2011; Su & Mark, 2008) label nomadic work an "extreme form" of mobile work. Unlike having an expanded number of workspaces at hand, nomadic workers are usually depicted as those who travel long distances the majority of the time, lack a stable workplace or organization to which they are tied, and have the responsibility to manage and carry their resources as they move about (Rossitto & Eklundh, 2007). For whatever reason—be it to find privacy, ambience, clients, to socialize, or otherwise—a nomadic worker is someone who often moves his or her workplace *across* different locations (de Carvalho et al., 2011), a situation that might vary dramatically over time (Lilischkis, 2003).

Both mobile and nomadic works are also likely to involve other instantiations of mobility like a high degree of mobility between projects and clients. That is, while the organization, work routine, and fundamental bases for the sorts of work that nomadic workers do remain largely defined and stable, the specifics of these workers' tasks and the parties that ultimately request and dictate these tasks often do not. As such, both mobile and nomadic work entail a high amount of cognitive dexterity to navigate these varying tasks, tools and technologies.

Most discussions of mobility and work also mention several other distinct worker-types including teleworkers, satellite workers, and freelance 'off-roaders.' *Teleworkers*, or telecommuters, although typically physically distant from a permanent, centralized workplace, are actually quite stationary throughout a day. Teleworkers usually substitute and set up a 'home base' in one location in order to perform their professional tasks, perhaps domestically, in a telecenter, in a shared co-working building, or a coffee shop (e.g., Hilbrecht, Shaw, Johnson, & Andrey, 2008; Liegl, 2014; Middleton, 2008; Spinuzzi, 2012). In some cases, teleworkers form distributed or virtual teams as they collaborate from remote locations (e.g., Hinds & Cramton, 2013; Olson & Olson, 2014).

Closely related to teleworkers are those individuals who work in satellite offices and those who work with unassigned or reserved seating in workspaces, such as hotellers and hot-deskers (e.g., Hampton, 2014). Lastly, there are also workers who operate in near or total freelance mode as "*offroaders*" (Harmer & Pauleen, 2012). These individuals perform work tasks whenever and wherever they need to, with—reportedly—much

autonomy, pleasure, and novelty in what they do and for whom they do it. Some self-employed individuals also fall into this category (Barley & Kunda, 2006).

McDermott (2005) offers detailed evidence of the situational context of certain mobile workers noting that, increasingly, these individuals are displaced from their bosses, working in various time zones or from remote sites such as home offices and airport lounges. Further to this point, Middleton (2008) reports that several organizations are implementing changes that force—that is, require rather than simply enable—employees to either give up their offices or to extend their work environments beyond the traditional office. This said, mobile work in all of its forms—nomadic, mobile, telework, and so on—should not be thought of as merely spatially mobile (in terms of where it occurs). Mobile work can also be contextually mobile (in terms of what cultural, temporal, and other boundaries must be navigated to undertake it), and/or technologically mobile (in terms of what devices and resources enable successful work mobility at all) (Cousins & Robey, 2005; Su & Mark, 2008). At any given time, workers may or may not 'be' mobile in any of several different ways, including spatially, contextually, or technologically.

Perry (2007) refers to the overhead responsibility of "mobilisation work" shared by all types of mobile workers: that of proactively planning and anticipating for mobility levels, spatial contexts, temporal shifts, and social interactions on a daily basis. Mobilization work eases, but does not always solve, some of the salient difficulties and challenges that mobile professionals face (Knox, O'Doherty, Vurdubakis, & Westrup, 2008; Su & Mark, 2008). These include not only practical issues of resource depravity, unfamiliarity with resources and services that are available off-site, corporate invisibility, loss of 'social capital,' isolation, under-recognition for achievements, and troubles balancing work and life (see also IBM, 2005; Koehne et al., 2012; Olson & Olson, 2014), but also a destabilized sense of self and self-identity (see also Büscher, 2013; D'Mello & Sahay, 2007).

Furthermore, the pressing need for mobilization work by mobile knowledge professionals elucidates an important secondary current that runs deep beneath all of these forms of mobile work: boundary-crossing. Boundaries both physical, in terms of geographies and companies, and virtual, in terms of the suites of technologies and resources used, are traversed during mobile work. This is nowhere more in evidence than in the increasingly project-based influence that knowledge work has upon mobility (e.g., Barley & Kunda, 2006; Garsten, 1999), with professionalization re-envisioned as a drive toward achievement and outcome rather than toward hours of effort clocked in particular locations.

Bleeding and blurring between previously bounded spheres in these ways calls for an adroitness and navigational mastery as well as honed tacit skills that are critical to successful work performance (Cousins & Robey, 2005).

Mobile work and work-life balance

Beyond these skills and capacities, however, lies a parallel set of issues under discussion related to the place of work within the larger context of life (Fleetwood, 2007; e.g., Hyman & Summers, 2004; e.g., Nippert-Eng, 1995) and the role, if ambivalent, of technology in contributing to an 'always available' work culture (Gant & Kiesler, 2002; Hyman & Summers, 2004; M. Mazmanian et al., 2013; Sadler, Robertson, Kan, & Hagen, 2006). This 'work-life balance' discourse, exemplified in the blurring between professional and personal life spheres, is extensively discussed in relation to mobile workers for whom such concerns become ever-more visible (Cousins & Robey, 2005; Mazmanian et al., 2013). On the one hand, technologies enable flexible timing and locations for work, but in so doing they also allow workers and managers alike to permeate what were previously fairly hermetic boundaries between work and life. The intrusion of work calls during personal hours and personal calls during work hours (Prasopoulou, Pouloudi, & Panteli, 2006; Sadler et al., 2006) is but one small example. Mobile technologies like BlackBerries have been found to be work-extending (Middleton, 2008), and the email-processing capabilities of smartphones and personal digital assistants (PDAs) forces them quickly to become imbricated as agents in this issue. The result vortex is thought by some to be a self-perpetuating cycle that shifts workers' behaviors, identities, and organizational cultures toward an unsustainable norm of total accessibility (M. Mazmanian & Erickson, 2014; M. Mazmanian et al., 2013). As such, those who work across spaces must find new methods for boundary management, the tactics of which are usually left to individuals' subjective judgments (Middleton, 2008; Nippert-Eng, 1995; Sørensen, 2011).

In sum, the existing literature often conflates multiple terminologies to investigate the varying phenomena that comprise the experience of mobility of work. More generatively, this wealth of literature yields a salient delineation of factors based on three primary dimensions—spatial, contextual, and technological—each of which instantiates a particular set of boundaries for workers to negotiate. The *spatial* aspects of mobility concern where work happens, which is increasing across diverse spaces such as airport lounges, home offices, client offices and hotel rooms. Correlatedly, workers face challenges when they mobilize resources in non-traditional work spaces, necessitating their additional

"mobilisation work" (Perry, 2007). Contextual aspects of mobility involve the various environments within which mobile workers operate, as well as the multiple roles they must take up to do so. How the temporal orders of social practice shift when knowledge workers become more mobile are also included here (Cousins & Robey, 2005; Prasopoulou et al., 2006). The navigation of contextual boundaries manifests itself most often as a dialogue about work-life balance revolving around the apparent dissolution of personal and professional domains (e.g., Hilbrecht et al., 2008; M. Mazmanian et al., 2013). Mobile workers deal too with technological mobility, a measure that more concerns how connected they are to suites of technological resources than how spatially or temporally distant they are from a central locus.

It is not difficult to see that within these discussions that digital infrastructure constitutes a key dimension of mobile knowledge work, both enabling and constraining the way mobile workers organize work practices on the move and away from technological resources that are available in the traditional office. We turn to this topic next.

Infrastructure

The constitution and execution of mobile knowledge work should in many, if not all ways, be exemplified by the research comprising the previous two areas of discourse. On its surface, mobile knowledge work is knowledge work constrained and enabled by the sociotechnical experience of mobility. Yet, our last foray into the literature suggests that we do ourselves a disservice as researchers if we overlook the role of infrastructure in this mix. Working in both fixed as well as mobile situations is increasingly one of leveraging—and in many cases, negotiating and aligning—multiple infrastructures, some of which are more overt or appropriable than others.

For most of the pre-Internet era, infrastructure was thought of solely as large-scale technical systems, typically at a national scale (Rinaldi, 2004). Infrastructures are systems in that they have many components that have inter-relationships and must function as a whole. But, to be an infrastructure, these systems must be pervasive and act as an enabler or substrate for other actions or opportunities (Hughes, 1993). For example, the U.S. national highway system allows for commuting, vacation, long-haul trucking, and the quick repositioning of U.S. National Guard (military) units in emergencies[1].

[1] It is worth, perhaps, noting that most movies or shows of a post-apocalyptic world showcase the loss or absence of key infrastructures. Seen this way an infrastructure is what makes society modern: its absence makes

Infrastructures are large-scale, technological, political, and institutional entities. They are designed to 'live' for extended periods of time, and to adapt over time to new uses/expectations of use and new to incorporate new technologies along with the old. Functioning optimally, an infrastructure of any sort will serve the role of a crucial support system for overlaying tasks (e.g., Edwards, Bowker, Jackson, & Williams, 2009; Pipek & Wulf, 2009; Semaan & Mark, 2011) , and in so doing will fade to (near) invisibility. It is during a 'breakdown,' however, that infrastructures become visible or become closely relevant to action.

In more recent times, the development of digital technologies and the resulting shift to new ways of generating and sharing knowledge, notably in science, have ushered in a new era of infrastructure studies, a nascent field that draws from science and technology studies, the sociology of work, computer-supported cooperative work, organizational studies, information systems, and sociotechnical systems design (Edwards et al., 2009; Jackson, Edwards, Bowker, & Knobel, 2007; Tilson, Lyytinen, & Sørensen, 2010). To date, this area has focused primarily on a type of infrastructure known in the United States as 'cyberinfrastructure' or 'knowledge infrastructure' and in Europe as 'e-infrastructure.' Generally speaking, a cyberinfrastructure is a large scale, interconnected digital ecosystem that stretches across space and time to support a specific scientific or professional goal (Monteiro, Pollock, Hanseth, & Williams, 2013); many times cyberinfrastructures are designed specifically to facilitate research in a specific scientific area or support a particular group of scientists.

The world of knowledge work as we have outlined it above—a largely individual, creative, problem-driven initiative—does not fit neatly within the collective, often lab-based model of cyberinfrastructure. Yet it does reflect a parallel strand of infrastructure studies that is attempting to understand the relations between the smaller, heterogeneous infrastructures that people use to accomplish their work ((e.g., Edwards et al., 2009; Pipek & Wulf, 2009; Semaan & Mark, 2011). This need for infrastructural assembly, or *bricolage*, exponentially multiplies the associated boundaries and constraints between and among different infrastructures, which occasions a corresponding need for active (and sometimes creative) management (Vertesi, 2014).

This line of research does not (yet) define infrastructure in strict terms, but tends to agree to a definition that includes multiple types of software, hardware, and related technological

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us primitive.

artifacts, usually fashioned into a functional ecosystem or ensemble. The size and complexity of infrastructural technologies and the characteristic that they generally build upon existing technologies, make researchers direct their focus from ICT or isolated technological artifacts to a more complex notion of digital infrastructure (Hanseth, Monteiro, & Hatling, 1996). This work further highlights the sociotechnical nature of the digital infrastructure which not only includes a diversity of technological artifact but also human habits, norms, politics, standards, temporal rhythms and roles, that may prove its most intractable elements (Bowker, Baker, Millerand, & Ribes, 2010; Jackson et al., 2007).

Mobile workers have different relationships to infrastructures than do more stationary employees. As noted above, a key challenge for mobile workers is their need to gain access to resource(s) while on the move, which forces a concomitant need to interact dynamically and often repeatedly with infrastructures. Independent of any need to remain in a singular place to carry out their work tasks, mobile knowledge workers go to great lengths to configure numerous tools in locally particular ways in order to ensure that information is accessible, creating infrastructural configurations that will "move with the worker or [be] found in the places in which the worker moves" (Davis, 2002, p. 69). They continuously enact "unanticipated responses" (Davis, 2002, p. 68) to uniform technologies and use technology in response to their changeable, undependable working conditions.

However, the seams (Vertesi, 2014) among these improvisational and assembled parts tend to remain persistently visible for in these cases because of the increased number of barriers and opportunities for breakdown that mobility engenders (Su & Mark, 2008). It is typically necessary to navigate varied sets of constraints that can alter their access to both enterprise and personal information resources. For example, employees using smartphones and tablets are regularly frustrated in their attempts to securely access, store, scan, and print information on the road or while working remotely (Reuters, 2012). In addition, workers find it challenging to maintain consistency among multiple devices and applications (de Carvalho et al., 2011; Voida, Olson, & Olson, 2013). These infrastructural failures become especially salient when work is time-sensitive or highly interdependent.

Mobile knowledge workers' creative assembly, arrangement, and enactment of digital infrastructures into 'kits' or 'ensembles' can be seen as a form of 'gateway' making (Edwards et al., 2009). Gateways are strategic points where workers have formed a bridge to or connection between different infrastructures. The workers often have to draw upon competing infrastructures (e.g. Mac vs. PC infrastructural systems); which are not used in isolation, but overlap, often messily (Vertesi, 2014). Multiple incompatible infrastructural systems may

collide and create infrastructural boundaries that plague work practices. To overcome these boundaries, mobile knowledge workers often leverage gateways to extend the range or purpose of a crafted infrastructural ensemble equating "locally constructed gateways to globally available systems" (Edwards et al., 2009, p. 370). As such, gateways involve a sophisticated understanding of how the socio-echnical standards and elements of a particular working context are laid out. Indeed, one's strategy may be to leverage supplied infrastructures or avoid them. Within work environments, the manifestation of aggregated infrastructural gateways is inconspicuously referred to as 'work infrastructure', which Pipek and Wulf (209, p. 455) define as "the entirety of devices, tools, technologies, standards, conventions, and protocols on which the individual worker or the collective rely to carry out the tasks and achieve the goals assigned to them." In this way, infrastructural alignments, even in their individual enactments, can be seen as a collective endeavor as individuals skillfully align between and across infrastructural systems (Vertesi, 2014). As Sawyer, Crowston, and Wigland (2014) indicate, these shared compilations and collections, especially when enacted in the same professional knowledge field, appear in basic form and structure as recurring patterns, though the specific details of these are variable.

These individually contrived assemblages impact one's ability to conduct business, document and share knowledge and gain access to information. To be a mobile knowledge worker is to be coupled to numerous, variable infrastructures continuously, yet infrastructures, as is increasingly noted, are highly situated and contingent systems in simultaneous relation to organizations, polities, communities, and other infrastructures as much as they are to the individuals that use them. As such, future questions with regard to control do need to shift toward acquiring greater understanding of both the complex sociotechnical environments in which work now primarily occurs, as well as the equally complex sociotechnical relationships these environments engender.

Finally, it bears stating that all of the mobilization work (Perry, 2007) and coordination work (Voida et al., 2013) that mobile workers perform to enable their professional practices become superordinate infrastructures in and of themselves. These infrastructures act alongside workers' digital infrastructures to continuously but tenuously support the localized, individual technological systems and the broader informational and professional systems of each. As a result, the macro structure of the digital infrastructure is in interplay with local adaptations of the infrastructure: Local adaptation of the digital infrastructure can potentially shape infrastructural processes and procedures at macro level and at the same time the emerging structures of digital infrastructure place demands on local

uses (Cummings, Finholt, Foster, Kesselman, & Lawrence, 2008). For this reason, the macro structure of the digital infrastructure never becomes routine or fixed. Because of the micro-level practices of actors (such as aligning between and across competing infrastructures at the local level) the digital infrastructure is always subject to negotiation, alignment and realignment at micro level.

In sum, we suggest that mobile knowledge professionals are a special population whose very mobility and need to accomplish work on the go yields a corresponding requirement to interact dynamically with infrastructures of all kinds. Infrastructures enable mobile knowledge work by providing the physical and digital substrates for act. Infrastructures also demand mobile knowledge workers adroitly leverage various infrastructures, attending to the seams that appear between various infrastructural elements. As a result, these individuals can come to possess a literacy or a set of capabilities that enables them to construct optimal individual infrastructure strategies (Bowker et al., 2010; S. Sawyer, Kaziunas, & Østerlund, 2012). Finally, infrastructure provides the vehicles to (re-)connect mobile workers with their peers, clients, collaborators and resources. Mobile knowledge work makes visible both the needs and issues with infrastructure in ways that more fixed work cannot.

Researching the Mobile Knowledge Work Triad

The three, distinct discourses developing within knowledge work, mobility and infrastructure studies each provide a rich foundation upon which to interrogate the empirical phenomenon we are calling mobile knowledge work. Converged, however, they make manifest a set of possibilities that might otherwise go overlooked, such as the strategic relationship between individuals and the ongoing maintenance of patch-worked sociotechnical systems, the integration and networking of sociotechnical systems required to manage projects (as a unit of work) between and among multiple organizational and situational contexts, and the perspective of use required by mobile workers as they traverse infrastructures in new and patterned ways. We proffer the mobile knowledge work triad (depicted as Figure 1 below) to kindle these nascent discussions and raise new questions about the ways that the convergence of knowledge work, mobility, and infrastructure is creating a new area of work and work practice.

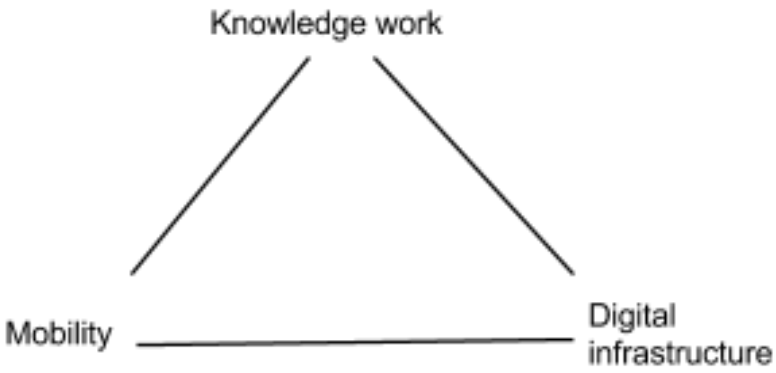

Figure 1. The Triad of Mobile Knowledge Work

Figure 1. Mobile Knowledge Work Triad

This triad makes visible a fundamental premise: these three elements are reciprocally entwined. In fact, the dynamic interrelations of these aspects shape how mobile knowledge workers draw on digital infrastructures and perform their knowledge-based work practices. Likewise, this triad makes clear that the creation, distribution, and use of knowledge by workers—as well as the use of digital infrastructure by workers—are mutually dependent. That is, the ways in which knowledge workers communicate and share knowledge is tightly coupled with the infrastructures that they assemble and build their work upon. Furthermore, in constructing and reconstructing their infrastructures in their practices, workers will leverage their knowledge.

More specifically, this convergence of research highlights interdependencies amongst knowledge, access, tools, and work arrangements that elucidate the tensions among these variables, determine trajectories of work and design, highlight the ways in which infrastructures become visible and invisible, and document salient patterns of relations across dimensions. This framing suggests a set of research questions that could progress our understanding of mobile knowledge work and, simultaneously, increase our understanding of the shifts and changes occurring independently in studies of knowledge work, mobility and infrastructure.

By way of concluding this exposition of the generative tangents within the mobile knowledge work triad, we close with this nascent set of queries in need of immanent investigation:

- How does mobility impact how knowledge work is done, especially temporal factors and sequential dependencies and interdependencies among colleagues?
- How does work change (if at all) because of the need for varied and dynamically assembled infrastructures to accomplish it? How is knowledge sharing accomplished while one or more team members are mobile? What tools are used or avoided, and why; what topics/issues are avoided, and why; what types of knowledge are employed or avoided?
- How do knowledge workers define working time and/or working space—where are, if any, the boundaries between work and non-work?
- How do workers best leverage borrowed infrastructures—both when in fixed, new locations and while mobile? What skills do they need to have to do this effectively?
- How do alternate workspaces like coworking offices accommodate mobile knowledge workers? What services/infrastructures do they provide; where do they see most demand?
- To what degree does any worker have more than a semblance of control over the infrastructures they use, even if the management structures or administrative requirements of their jobs afford them these liberties?

This paper has begun to conceptualize and describe an emerging form of knowledge work that combines physical mobility with dynamic interaction with technological infrastructures—what we call mobile knowledge work. As a set of workers, mobile knowledge workers compose a group of growing size, predicted to become even more visible in the near future (de Carvalho et al., 2011; Su & Mark, 2008). With the aim of pursuing greater theoretical clarity, we have begun to review and synthesize the ways that literature from knowledge work, mobility and infrastructure studies elucidate core features of this work and hint at unexplored research opportunities. The resulting set of research questions form the first steps of this inquiry and, hopefully, inspire fellow scholars to join the quest to outline mobile knowledge work, both theoretically and empirically, in the future.

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