An ecology of distributed knowledge work

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Introduction

This chapter explores distributed knowledge work as an ecology of knowledge workers, mediations, knowledge objects, documents, and data repositories.[1] These elements of the ecology are linked together through the dynamics of representation, design, and implementation. Those three aspects of the experience of engaging in distributed practice are ubiquitous, pervasive, and intertwining (Bowker and Turner, 2000). In the ecology of distributed knowledge work, representations are continuously being written and read, design is being enacted and evaluated, and implementations are being produced and reproduced.

Representing, designing, and implementing are, in a sense, the 'stuff' of which distributed knowledge work is made. Because representations are being created and interpreted by actors at many levels of a distributed system, it is a multi-layered hermeneutic process. Because designs of the system are always being enacted and evaluated, it is a path-creating, innovative process. And because implementations of the system are continuously being produced and reproduced, it is a process of responsible human agency. At any moment, any of the actors could interpret their situation differently, could resist the prescribed path, or could intervene to change accepted practices.

A central feature of this ecology of distributed knowledge work is the tension that individuals experience, both as knowledge workers and as knowledge objects, between the expectations of a local logic and those of a global logic. These two logics create a symbolic space within which the individual must navigate - a space that is marked by an irreducible contradiction between competing contexts for responsible action. I first present an ecological model of distributed knowledge work, showing its multiple tensions between local and global logics. I then discuss some recent research on distributed knowledge work that shows these tensions in action, and discuss the existential experience of humans as knowledge workers.

An ecology of distributed practice

A multi-level model of knowledge work

Figure 1 presents a simplified image of how knowledge workers, mediations, knowledge objects, documents, and data repositories form an ecology of distributed practice. It is a fragile, recursive network in which humans are both the principle knowledge workers and also the principle knowledge objects. Non-human actants (Latour, 1987; Callon, 1992; Law, 1992) have a role to play, to be sure, but it is the experience of the human being as knowledge worker and knowledge object that is of interest to me. Judging the value of a distributed system will always involve an assessment of how it is experienced by the professionals operating within it and the human clients who are affected by it. In that sense, evaluating a distributed system will always rest on how a person is affected by the system, internally or externally, and that is where I want to focus our attention. In addition to non-human actants, there are many other important elements that are not in this simple diagram, such as culture, history, and status. My intention is to refer to them, as needed, through the

human beings who are involved as its workers and objects.

[FIGURE 1 NEAR HERE]

The knowledge workers and knowledge objects in Figure 1 are engaged in reading and writing documents, thus constructing representations that mediate the interaction between those workers and objects as well as between the documents that feed into and out of data repositories. The knowledge workers and objects, together with other supporting actors associated with larger organizational and societal information systems who are not depicted, are also engaged in the design of those very documents and interaction processes. And finally, as they work in these systems - resisting sometimes, performing sometimes, and struggling to improve them at other times - they are implementing the distributed system of knowledge work. Representing, designing and implementing, then, are the way that the distributed practices of knowledge work are carried out.

The data repositories shown at the top and bottom of the figure are meant to be the same ones, and therefore at the same level**.** These repositories therefore provide a connection between the knowledge workers and knowledge objects, forming a circle, or more accurately, a Möbius strip, so that each time the circle is traversed the surface on which one is travelling seems to be new. The image of a Möbius strip captures in some degree the (often false) sense of eternal progress we associate with technology in general, and the advanced forms of distributed practice in particular.

For each of the three layers of the Möbius strip figure, I show on the left the different levels of logic that operate within it. The levels of logic range from the most local and

concrete to the most global and abstract. I see these ranges of logic, and the two extreme anchor points of the local and the global, to be important defining characteristics of the experience of action in any system, especially distributed knowledge work. Local logics, at the extreme, are the logics of face-to-face interaction in historically-bound moments of knowledge work. Culture, traditions, symbols, honour, history, and sense of future are all present and operating in determining the appropriate thing to do. Global logics, on the other hand, are experienced when a person engages in abstract analysis with logical relations among concepts, economic calculations, and attention to institutional or professional rules, so that an accountable, defensible reason can be given for a choice that is made.

Tensions between local and global logics

In Figure 1, knowledge workers are shown as being in a constant tension between the two logics of the local and the global. They engage in abstract, global logics when they write to, or read from, data repositories that are created and accessed by a wide range of professionals working across multiple disciplines. In dealing with a data repository, the logics they employ are not of the concrete moment, but of how the concrete moment 'fits' the closest approximation of the categories, measurements, and policies operating at the global logic level. At the same time, the documents they create and read while working with knowledge objects involve a local logic of their practice.

Take, for example, the physician who is treating a patient in a large teaching hospital. Her vocabulary will be unique to her own specialty and even to the local categories of patients, treatments, and relations with other medical and technical staff. It is thus a local logic for the physician. However, for the 'knowledge object' (the patient), these documents

represent a global, not a local form of logic. The patient's direct experience is translated into the higher-order constructs of a medical specialty, and the local logic that unites a patient's understanding of his disease or treatment within the medical system is of little or no consequence. As the individual moves from specialist to specialist within the hospital network, his immediate experience of local logic is carried through from location to location, but it is not a part of the global logic of the documentation that is being made of them by the knowledge-worker physicians.

At the data-repository level, something strange seems to happen. The most global logics of the physicians, insurance companies, government policy makers, or social scientists are turned into very local issues of measurement, standardization, detailed definitions of particularities, and exacting techniques for ensuring common and understandable formats for data entry and retrieval. At the same time, the most abstract, summarized syntheses of those categories and measurements become the existential ground for the local logics of the everyday person as a knowledge object (patient, citizen, etc.). They become the potent categories by which we are known as individuals, to all but our most intimate friends. They become the terrain that must be navigated by ordinary people day-to-day in order to get things done in institutionalized worlds such as health care, education, or government services.

The tension of the local and global logics as they cross each other from level to level in this simple depiction of distributed practice is the tension of reason versus experience, which has been with us in Western thought since at least Plato. I believe that the emerging field of distributed mediated practice is an important step in bringing these age-old tensions to our conscious awareness. We should expect that the more technically advanced and distributed our knowledge work practices become, the more we will encounter fundamental

question of human existence in our research of it. As computing and communication technologies become universal and pervasive in our lives, the questions that first stirred humans on a reflective, philosophical path return to us in a socio-technical presence. The computing and communication technologies that mediate distributed practice and make virtual teams possible also serve to raise philosophical issues about the nature of the modern world which can remain unnoticed and unexamined in their absence. Fundamental tensions between the local and the global, which are present even in the most basic forms of human interaction, are made visible and problematic when we introduce advanced technologies to mediate organizational practice.

Examples of distributed practice

The simplified representation of Figure 1 could be criticized because the distinction between local and global logics can be somewhat difficult to make, with the same documents representing local or global logics depending on the writer or reader. So I intend this conceptualization as an analytic distinction, useful for dissecting the overall structure and dynamics of distributed knowledge work and not intended as an exhaustive and exclusive taxonomy. Below I use the analytic distinction of local and global to discuss some recent research on distributed practice that displays the multiple, overlapping logics and the Möbius strip quality of their interrelation.

Interactions between local and global logics

Michael Barrett (Barrett, Cooper and Jamal, 2001) has studied auditors and their documenting practices in large-scale corporate financial audits. He argues that as their

documentation practices changed, their identities as auditors changed. I read this as saying that the documentation practices at the global level of their audit work led to a change in their local sense of identity. An earlier study by Barrett (Barrett and Walsham, 1999) shows a similar relation of documentation practices and professional identity in the insurance industry. As documentation practices changed, the identity of insurance brokers changed along with them.

In Carsten Oesterlund's recent Ph.D. thesis at MIT, he examined a large teaching hospital in which it was hard to comprehend the intensity of writing and rewriting of patient records by physicians, with its repetitious documentation of the same patient's symptoms and history. Why, the medical informatics community asked, couldn't the patient history be collected once and be electronically transmitted across all the specialists as the patient moved among them? Why, in other words, can't a global logic be used to structure the data collection? Oesterlund's answer was found in the multiple roles that documentation played in that distributed system.

First, each specialist has unique categories that are not duplicated by others. But, more importantly, each specialist is not just treating the patient but is also reflecting on the patient, and on medical knowledge generally, in a written dialogue with themselves. Further, each physician is also communicating with specialists on their own team across shifts, as well as with other teams of specialists. Each of these modes of communication raises unique requirements of local logic and as professionals, they will resist any attempt to homogenize that local logic into a less immediate global one through a common medical information system. At the patient level, in contrast, the physician's local logic of writing place the patient as an object in a global vocabulary of disease categories, syndromes of complications, and

standardized test results. The patient's actual experience is subordinated to the local and global tensions of the physician.

Language dynamics in software development processes

Our research team at Case Western Reserve University has undertaken several projects studying distributed teams which are of relevance to the ecology of practices discussed in this chapter. Here, I will focus on two such cases which illuminate the dynamics of local and global logics through 1) a study of the experience of space and time by distributed team members, and 2) the process of learning in a distributed system.

First, Alex Citurs (2002) has explored the dynamics of language use in distributed teams of software developers. He proposed that software development teams periodically experience moments of crisis during a project, that these moments of crisis are instances of learning, that are characterized by:

(a) a shift from the use of implicit language to the use of more explicit language;

(b) the emergence of new vocabulary elements; and

(c) an increase in the level of integrative complexity of their language practice.[2]

In 2001, he conducted a six-month study in of three software development teams located in the USA, India, and the UK who were working on a distributed project. Citurs found that they did indeed experience periodic moments of crisis in their work. He also found that the periods of crisis were associated with a shift from implicit to explicit language, the emergence of new vocabulary items, and an increase in integrative complexity. After the

crisis passed, language patterns returned to their pre-crisis state of implicit language use, fewer new vocabulary items, and reduced integrative complexity. But what was even more interesting to me was the finding that this type of oscillation in language practice continued in wave patterns throughout the project. Moments of crisis were correlated with peaks in these oscillations, but the oscillations were ongoing, even when the team members did not identify a crisis as occurring.

I take the oscillation in language use as an element in the tension between local and global logics that are experienced by knowledge workers in a distributed practice. The tension and the resulting oscillation between the local and the global are continuous. Language is always breaking down in the face of this tension, and is always being repaired - but in ways that lead to further breakdown. As language becomes more implicit, relying on nonverbal understanding, and as integrative complexity is reduced, the knowledge worker is coming closer to the local experience and relying more intimately on the local logic of practice. As this trend progresses, the global logic is threatened. Things happen in the local practice for which no global term applies. Communication between teams suffers. Their language then begins to shift in the face of this breakdown, becoming more explicit, inventing new vocabulary items to capture the local experience that is escaping the global logic, and building more integratively complex arguments to bring the diversity of local experience within a global framework.

This trend to strengthen the global logic leads to the emergence of new problems, in which the local practice is burdened by the attention to global logics and vocabularies. It is inefficient for the team to spend time being explicit, using integrative complex reasoning and inventing new vocabulary items. Their language practice then begins a reverse shift toward a

greater use of implicit vocabulary, less integrative complexity, and reliance on the existing lexicon.

I am really excited by the image of language as always breaking down and always being repaired in ways that keeps reversing itself. I see this as an aspect of our existence which is not apparent to us in our day-to-day experience, but is highlighted for us in the study of distributed practice. That this language dynamic generally remains hidden from us is, I believe, related to the way we privilege space over time in our thought. Temporality is almost impossible for us to express in language, or to think about in its own terms. The very idea of temporality has to be translated into a spatial representation in order to be conceptualized in language. Time is shown as a line in Cartesian space. Temporal duration is discussed as movement along the line. An instant of experience is a limitlessly small point on the line. In this way, our ability to conceptualize the dynamic nature of language use and learning is made within a spatial framework that includes built-in inhibitions against a thorough-going sense of temporality. Learning is therefore associated with the concepts learned, which is a spatialized representation of learning, not the temporal process of breakdown and repair in language. But that is a topic which needs to be explored in more depth elsewhere.

Another particularly interesting finding in Citurs' studies of distributed software development teams is the phenomenon of 'unblackboxing'. He discovered that teams writing software sometimes encountered an element of code that had been created years before and had been used as a modularized 'blackbox', but now no longer seemed to work as intended. The team was then forced to engage in 'unblackboxing' in order to unearth the logics employed in a module's creation. This "unblackboxing" required that they uncover the organizational processes and social context that were assumed in its original construction. In

essence, they were confronted by an element of their global logic (the blackbox module) that no longer applied to their local practice, which made them 'reverse engineer' an understanding of the lost local logics that had gone into its construction. Once again, we see language breaking down and being repaired as part of the continuous process of learning in the team, stemming from the tension experienced between local and global logics. To paraphrase Latour (1987), we like to think of language as being ready made, but instead it is always being made. And, I would add, being made in the tension of local and global logics.

Space and time experienced by outsourced computer administrators

My work with Ulrike Schultze (Schultze and Boland, 2000) revealed the importance of two ways in which space and time were experienced (known as space and place) through an ethnographic study of the experience of outsourced computer administrators. Place is the experiencing space and time by having a sense of being in place, having a place, and understanding how things work because of the place we are in. Place is local logic, tradition, accepted practice, and a shared sense of 'how we do things here'. Space, on the other hand, is the experience of space and time by having a sense of an abstract, homogeneous, limitless world in which laws of nature hold universally, and in which local practices are quaint anachronisms of little significance.

The computer system administrators that Schultze studied were caught between a desire to be aligned with a sense of space, in order to strengthen their claim to professional expertise and high consulting rates, and a desire to belong in the organization - to have a sense of place that could make their day-to-day work more humanly satisfying. Schultze's study of these teams showed how their attempts to break out of the tension they experienced

only served to reproduce the very conditions that made the tensions possible. In order to have professional satisfaction in their work, the administrators sought to define themselves as 'third level' computer system workers. This meant that they dealt increasingly with the most arcane and deeply embedded system-level aspects of the computer installation. Yet, this attempt to gain professional satisfaction and to enable them to be more marketable as consultants on future assignments meant that they were less able to experience a sense of place in the organization. Further, they were increasingly seen as 'commodity workers' who had so little organizational knowledge that they could easily be replaced. This, in turn, caused them to seek to strengthen their professional competence and value by moving even further into the sense of space found in the most esoteric levels of the computing system software.

In short, the tension of local and global logics as manifest in the experience of space and place resulted in behaviours that served to reinforce the field of tensions initially giving rise to their discomfort. As in the language breakdowns that were seen to drive learning in Citurs' work, the tensions of local and global logics encountered by the computer administrators in Schultze's study had created a cycle of breakdown and repair, and served to reinforce the very tensions they tried to escape.

Conclusions

I have proposed in this chapter that distributed practices can be productively viewed as a multi-level ecology in which each level is characterized by a tension between local and global logics as they are experienced by human actors. I have given some research examples that are relevant to understanding the dynamics of these local–global tensions in distributed knowledge work settings. The research suggests that there is a recursive, self-propelling

process of language use in which breakdown and repair create and recreate the very conditions that give rise to tensions in the field.

A larger issue raised by the ecological view of knowledge work presented here is the shift it suggests in the emphasis of our research on knowledge work and virtual teams. The new direction that an ecological view suggests is one that emphasizes the existential experience of individuals as they engage with the tension of local and global logics. This existential direction approaches the study of organizational life as processual, temporal, and dynamic, with a focus on individuals and their subjectivity. It also emphasizes the importance of a structuralist analysis to the study of organizational life.

By structuralist analysis, I mean an approach to studying knowledge work that unpacks the oppositions associated with the tensions experienced in organizational life, such as local versus global, and how those oppositions create a space for playing out knowledge work. An existential study of knowledge work will reveal how actors partition their ongoing flow of experience with oppositional language that symbolizes differences between self and other, core and periphery, freedom and control, and other binary oppositions forming their field of action. Hopefully, this existential approach will strengthen a more thoroughgoing sense of the temporal flow of organizational life and an appreciation of the unavoidably ethical basis for our engagement with that flow as we produce, and reproduce, through language the conditions we experience. The processes used by organizational actors for representing, designing, and implementing both make and navigate a space for engaging with the tensions that characterize organizational life. An ecological approach to the study of knowledge work as a distributed practice gives us a way to begin studying the existential experience of making, and moving, within that space.

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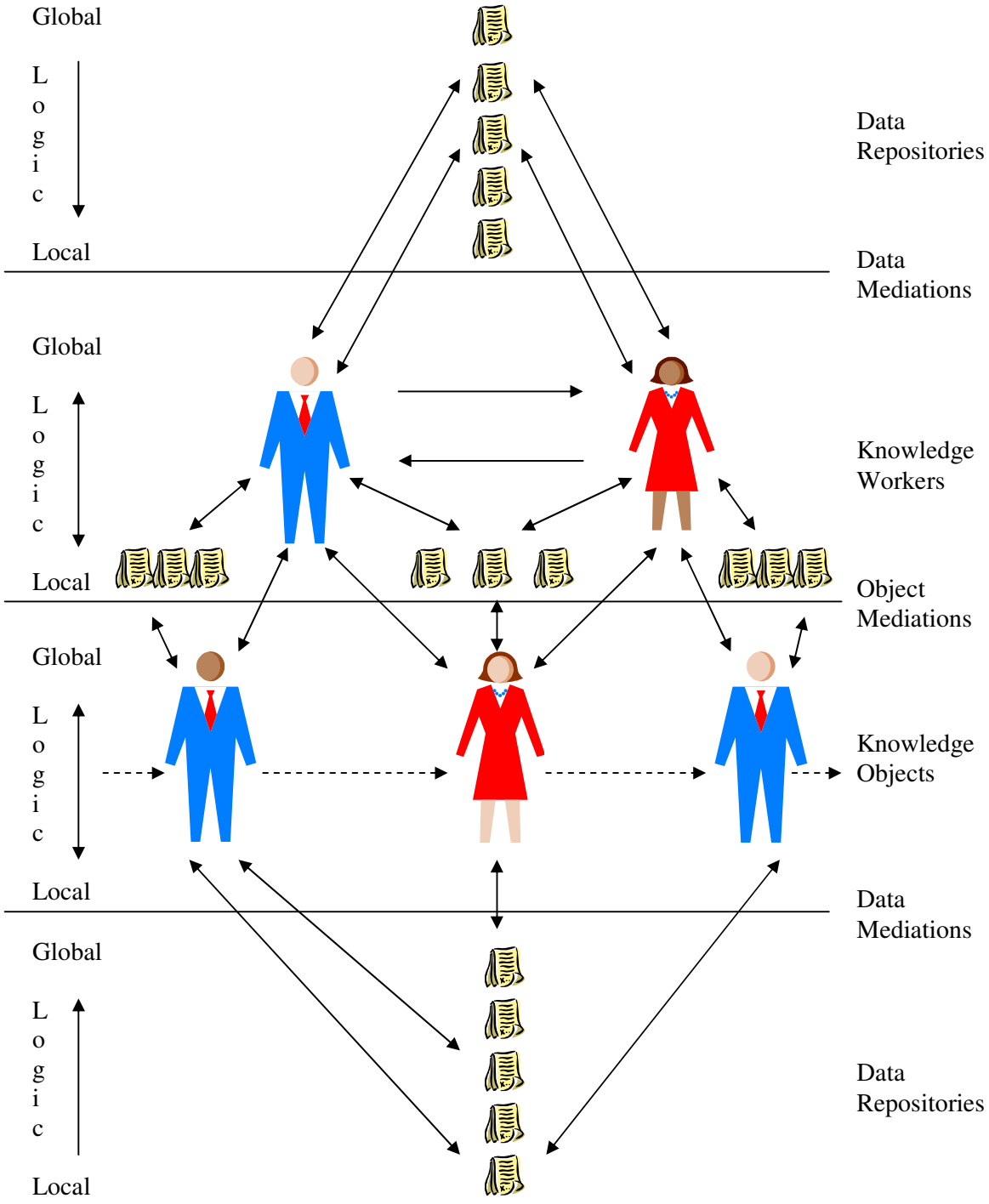

Figure 1. An ecology of distributed practice

Notes

1. For background on key issues relating to distributed knowledge work see Boland, Tenkasi and Te'eni (1994) and Boland and Tenkasi (1995).

2. Integrative complexity is measured as the number of distinct concepts being dealt with as an integrated whole, and the number of relations understood to exist among those concepts.