Working Paper

Spatial Structuring at Work: Comparing Physician Use of Computer Mediated Communication

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Abstract

This paper uses the disparate spatial practices of radiologists and outpatient physicians to frame a study of the relationship between communication technology use and the spatial organization of work and workplace change, with a particular focus on the control each specialty was able to exert over the use of computer mediated communication (CMC) to change their work. Drawing from diverse urban, organization and economic literatures, I propose a spatial structuring approach to studying this relationship. From a structuring perspective, spatial practices are seen as both shaping and being shaped by information technology use. I apply this approach to a mixed methods, empirical research project situated in the two medical specialties mentioned above.

For radiologists, their historic spatial practices contributed to both their need and their ability to control the use of teleradiology applications. Radiologists have done their core work remote from their patients since the inception of their profession. This history shaped the active role U.S. radiologists have played in determining the use of teleradiology.

In contrast to radiologists, outpatient physicians have historically constructed their core work as being done face-to-face and synchronously with their patients. As a result, they showed less inclination and ability to control the use of information technologies which increased and changed those portions of their work that can be performed remotely.

Spatial practices also help explain the very decision to use information technology. A logistic regression analysis finds that geographic location - specifically the size of city in which a radiologist's group is located - correlates significantly with the probability that a radiologist's group uses teleradiology.

1. Introduction

In the early 1980s futurists, led by Toffler (1980), famously predicted a new world of work. Communication technologies were to liberate workers from the despotic bounds of their offices, leaving them free to pursue their careers from the comfort and autonomy of their poolside decks. In subsequent decades, many of the assertions of these futurists were repeatedly debunked. Face to face contact continued to be crucial for many workers, as the importance of tacit knowledge became increasingly clear (Freeman 2002, Glaeser and Gaspar 1998, Olson et. al. 2002, Storper and Venables 2004). As for teleworkers, rather than the liberated workers predicted by Toffler, researchers found many teleworkers exhausted and isolated, working in a home that had lost its status as sanctuary (Gurstein 2001, Johnson 2002).

However, while this past research testified to the continuing importance of space in even the most technologically advanced workplace, the precise mechanism through which space influences the processes of workplace change has rarely been the focus of empirical studies. Very little research on communication technologies in the workplace has focused on the salience of the ways in which professionals worked in space before adopting a given technology. In this paper, I propose that professionals' spatial practices - the way professionals work in space - are not only shaped by their use of communication technologies, but shape their use as well. Three aspects of spatial practices emerged as particularly important factors in shaping the use of computer mediated communication (CMC) and related communication technologies in the medical professions discussed below: the proximity with which physicians worked to their patients and to one another; the physical layout of the office space; and geographic location.

I term this a "spatial structuring approach," where spatial structures are seen as both shaping and being shaped by human action. I illustrate this approach by contrasting the way that

radiologists and outpatient physicians have used CMC to change their work. In so doing, I demonstrate the extent to which physicians' spatial practices prior to adopting communication technologies shaped their use of the technologies. This paper thus contributes to a theory regarding technological change, work and space. In so doing, it links macro theories of urban theory and micro-theories of organizations.

Synthesizing an understanding of spatial issues and communication technologies in the workplace is particularly relevant in light of the resurgent concern around outsourcing and offshoring in the United States. In recent years, old concerns about the outsourcing of labor to developing countries have resurfaced, but with different jobs at risk. Whereas the outsourcing trends of the 1970s and 1980s impacted largely blue collar workers, the new outsourcing is placing pressure on previously untouched white collar occupations. Business services appear to be the most endangered (Kenney and Dossani 2003) and computer engineers have received particular attention (Thurm 2004), but other occupations are often mentioned in the popular press, particularly radiology (Pollack 2003). CMC use and spatial practices are at the heart of the offshoring process. In this paper I am proposing that paying more attention to current spatial practices will allow social scientists and policy makers to better predict the use of communication technologies to enable future spatial practices, including offshoring.

2. Bridging literatures: Workplace Change, Space and Communication Technologies

By the late twentieth century, issues of space, information technology and power had moved to the foreground in the writing of several prominent social theorists. All three are key to Anthony Giddens' notion of time-space 'distanciation' – the idea that the use of various technologies have extended social relations in time and space (Giddens 1981). Giddens illustrates distanciation through the invention of writing, linking this to a fundamental extension

of social relations in time and space. Giddens contends that this extension was primarily driven by the desire of those in power to better coordinate the people and resources over which they exerted power. In a similar vein, Beck (1992) convincingly argues that a defining consequence of the spread of information technology in the workplace will be the increasing prominence of struggles over information flows, due in large part to the spatial changes in production enabled by information technology.

Social theorists such as Beck and Giddens have informed both workplace research and urban research. However these two literatures have remained largely discrete. Broadly speaking, urban theorists who write on information technology have focused on the relationship between IT, power and space to the exclusion of the role of organization level processes in leading to outcomes, while workplace theorists have tended not to focus on space in their analyses of the relationship between the adoption of information technologies, control and workplace change.

Not unexpectedly, given the prominence of space in geographic thought, urban geographers have historically led the way in investigations of space and power. The French urbanist and radical geographer Henri Lefebvre (1974) called attention to space as a product of social practices, arguing that human intentions produce and reproduce space (33). Lefebvre's work stresses the malleability of space, as well as its social production, a position reflected in much subsequent work in Anglo-American geography (Gottdiener 1984; Gottdiener and Hutchison 2000; Harvey 1985a; Massey 1985). To Lefebvre the spatial practices of a society "secrete that society's space" (1974, 33). He defines spatial practices as embodying the perceptions and daily routines with which people link the places of their everyday life (38). Spatial practices are thus the ways that individuals make sense of everyday reality, and include

"routes and networks, patterns and movements that link together spaces of work, play and leisure" (Merrifield 2002, 90).

The iterative nature of the process through which human action produces spatial structures which go on to enable and constrain their future actions was given further voice in the writings of geographers influenced by Giddens' structuration theory (Gregory 1985; Harvey 1985b; Pred 1981). To be clear, these theories are most concerned with the very material urban places and structures which result from the spatial practices of a society. While my research focuses on different outcomes, I draw from these geographers the notion of the routine, everyday processes through which people perceive and act in space, and the iterative dynamics through which these processes shape daily life.

While the work of these geographers calls attention to the link between technology, location and control, these analyses did not focus on communication technologies as such. More recent urban theorists have focused squarely on communication technologies and spatial change. Among others, Castells (1989, 1996) and Sassen (1991 [2001]) have linked communication technologies to increased spatial, social and economic polarization, not only between both rich and poor individuals, but between rich and poor localities. Inasmuch as any urban researchers have focused on technology and the workplace, however, they have tended to overlook the role of the organization level processes through which information technology use comes to influence workplace change.

Organization researchers have been particularly focused on precisely these processes. Within organizational studies, structuration theorists have long identified the importance of discussing technology in terms of the social structures in which they are imbedded. At the heart of structuration theory is the idea that "structures exist only in their instantiation in the

knowledgeable activities of situated human subjects, which reproduce them as structural properties of social systems embedded in spans of time-space" (Giddens 1984, 304). Human actions create social structures which go on to shape future action, in an ongoing and iterative structuring process.

Structuration theorists who research the use of technology in the work place have postulated that technologies can be conceived of as social objects (Barley 1986). They describe a recursive relationship where technology is created and changed by humans but then comes to appear a part of the objective, structural properties of the organization, where it acts to both restrain and enable future human action (Orlikowski 1992, 2000). A distinguishing characteristic of this structurational model is the emphasis it places upon the role of human actors in producing, reproducing and changing structural properties, rather than the effective reification of structure which is typical of other theories in the field. Thus, structuration theory has been described as a process theory (Barley and Tolbert 1997).

To some extent, the difference between the two groups of literature is a matter of emphasis. Some workplace theorists do focus on spatial issues -- research around distributed work groups is particularly likely to incorporate some mention of spatial location, albeit in a much less central way and generally without an explicit focus on the use of information technology to change work (O'Leary and Mortensen 2005; Hinds and Kiesler, eds 2002). Correspondingly, a sizable body of urban research attempts to incorporate workplace change into theories of urban change (Gaspar and Glaeser 1998; Gordon 1984; Gurstein 2001). This is especially true of research into telework, where issues of work most obviously intertwine with urban issues of commuting, social relations and civic involvement.

Researchers in both traditions reference some of the same social theorists, and their

findings are often complementary. For instance, Castells' description of the way in which the new order "imposes itself as a natural phenomenon that cannot be controlled or predicted, only accepted" (1989, 349), seems to resonate with Orlikowski's analysis of the way in which a new computer tool came to be so accepted, that the constraints it placed on new programmers were invisible, even to the programmers themselves (1991).

What remains lacking is a systematic approach that links intra-organizational processes of workplace change to larger macro processes of spatial change. When workplace researchers refer to space, not only do they tend to limit themselves to physical location (O'Leary and Mortensen 2005) they are focused on space within an organization (Osterlund 2002). In contrast, when urban theorists speak of workplace change, they tend to be speaking in the aggregate without properly attending to the processes which underlie changes in the workplace. To speak to this gap, I propose a spatial structuring approach.

Orlikowski and Yates offer a useful perspective in their work regarding the structuring of time in organizations. They apply a structuration model to the analysis of time in organizations, treating temporal structures as "both shaping and being shaped by ongoing human action" (Orlikowski and Yates 2002, 684). As an illustrative example, they cite workers who work overtime so often that they transform the temporal structure of their work day.

This article brings a similar understanding to bear with respect to the way spatial structures both shape and are shaped by human action. I propose that workers' spatial practices shape the ways that they use communication and information technologies. Extending this argument, I further propose that information technology use is not only shaped by the way workers enact their work in time and space, but it goes on to shape the way they work in time and space.

By examining two medical subspecialties who enact notably different spatial practices in their work, I investigate this proposition. I would expect the different spatial practices with which outpatient physicians and radiologists have historically performed their work to play a role in shaping their use of communication technologies in the workplace.

3. The Spatial Practices of Medical Work

Medical sociologists have long distinguished between physician control of their core work and physician control of the terms and conditions of their work (Fielding 1990; Freidson 1970; Hafferty and Light 1995; Halaby and Weakliem 1989). While the distinction appears in various guises throughout the literature, the physician's core work is generally seen as the clinical aspects of the physician's work, while the latter applies to such factors as pay, hours, organizational structure and employment status. Thus, in the case of outpatient physicians, the core work would be examining and diagnosing their patients, while for radiologists their core work would be reading and interpreting films.

I propose that focusing on the spatial practices surrounding a subspecialty's core work will be particularly useful in exploring the role of space in the adoption of an information technology. Radiologists traditionally worked at some distance from their patients, both spatially and temporally. Within a decade or two of the founding of radiology, an ancillary discipline of radiological technology had evolved to take over the tasks of actually performing the examination and developing the images (Linton 2001, 23). The potential distance between radiologists and their patients was expanded even further with the advent of home computing and digital radiology. In addition to working in reading rooms down the hallway from their patients, radiologists now work from their homes and from offices which can be thousands of miles from their patients, interpreting images sent directly to their computers.

At first such teleradiology - the practice of reading images remotely - was heavily constrained by the low bandwidth allowed by early telephone modems. In the late 1980s, when radiologists first started interpreting images from home, even low resolution pictures took an inordinate amount of time to upload. However, as broadband connections grew more common, radiologists grew more capable of working from a distance. Currently, radiologists can use secure Internet connections to quickly receive radiological images of the same quality that they would see in their hospital practices.

The use of teleradiology has also enabled the fast-growing phenomenon of 'nighthawk' radiology. A recent scarcity of U.S. radiologists has created an immense and growing demand for radiologists to read the night tests increasingly required for emergency room diagnosis (Levy and Goelman 2005). Nighthawk radiology allows conventional radiology groups to contract with specialized 'nighthawk' radiology groups to interpret their night images. These nighthawk groups use teleradiology applications to receive images from hospitals located across the U.S. and to consolidate and distribute these images to radiologists who can interpret them from virtually anywhere in the world.

In contrast, outpatient physicians continue to enact their core work of interacting with their patients face-to-face in an exam room. As described elsewhere (Goelman 2005a) outpatient physicians see the face-to-face nature of these interactions as both practically important, in terms of quality of patient care, as well as emotionally important both for their patients and for themselves. An increasing number of outpatient physicians are adopting Electronic Medical Records (EMRs), one of the most rapidly diffusing technologies in health care. In recent years, politicians from Hilary Clinton (Rose, *The New York Post*, January 13, 2004) to George W. Bush (*Wall Street Journal*, April 27, 2004) have called for the faster adoption of EMRs. As their name

implies, EMRs are a technology that allows doctors to record and store patients' information electronically rather than on paper. Outpatient physicians have used EMRs to extend the spaces from which they can do their work. While they continue to meet their patients face to face, they remotely consult with other physicians via the EMR and use the EMR to document patient visits from home, as well as from the office.

One way of illustrating the difference in the spatial practices of outpatient physicians and radiologists is to ask: what work can be done remotely in each case? For outpatient physicians the work that can be done remotely - documentation and remote contact with their patients and colleagues - is not perceived as their core work. However, in the case of radiologists, they can do their core work of interpreting images remotely. This distinction played a large role in shaping these physicians' attitudes towards their remote work as well as the CMC they have used to enable it. Additionally, this distinction meant that radiology core work faced a threat of offshoring almost entirely absent from the work of outpatient physicians.

4. Methods

I drew on mixed methods in exploring the questions under investigation. Given my concern with understanding the *process* of change, qualitative techniques were the primary method upon which I based this analysis. As Maxwell (1996, 20) notes, qualitative research is particularly adept at asking "*how* x plays a role in causing y, what the process is that connects x and y" (italics in original). I also chose to emphasize qualitative methods due to the recent nature of the adoption of EMR applications. The uses of these technologies are in such a state of flux that past general trends may be less useful in predicting the future than the perspectives of the physician participants who use these technologies every day.

However, I was also interested in illustrating the broader context of the changes I was exploring in interviews. In addition to the interview data, I analyzed recent survey data of radiologists in order to explore the extent of teleradiology adoption in the wider radiology market place and the degree to which the use of technology correlated with other practice characteristics.

4.1 Qualitative Methods: Interviews and Site Visits

I completed 69 interviews of 60 participants in conducting this research. In the outpatient context, I completed a total of 40 interviews of 35 participants, as well as a focus group of an additional 22 participants.[2] For the most part, these interviews took place at one of three outpatient clinics, each located in the same large Northeastern city. In the radiology sites that I studied, I completed 29 interviews of 25 participants. I interviewed 15 radiologists, as well as an additional 10 people involved in all levels of the nighthawk radiology groups.

Where possible, interviews were performed on site. This allowed me to combine site visits with interviews. However, a significant minority[3] of interviews were done over the phone due to scheduling or travel constraints. Most participants were identified by other participants through a snowballing process, but as the research advanced, some were also selected by theoretically motivated attempts to find contradictory evidence.

The majority of interviews were tape recorded and transcribed verbatim, with the exception of five phone interviews which were not recorded. Transcribing interviews verbatim lessens the possibility that researchers will misremember or misrepresent the words of their participants --mitigating what Maxwell (1996, 89) terms “threats to valid description.”

I began the coding process by reading through early interview transcripts to establish

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[2] I interviewed 22 outpatient physicians, as well as 3 administrators, 2 physician / computer scientists, 2 executives at a medical insurance provider in the area, 1 medical informatics expert, 1 information technology officer, 1 filer, 1 nurse, 1 nurse-practitioner, and 1 physician-assistant.

[3] 7 out of 41 interviews in the outpatient case, and 9 out of 29 interviews in the radiology case.

categories related to my research question. I then coded the data using QSR's N6 qualitative software program. As Strauss and Corbin note (1998, 101), the coding of interview data is a "dynamic and fluid process." While it is conceptually useful to divide the coding of qualitative data into neat stages of "open coding" where categories are established and later stages where categories are classified and compared, in practice, these stages of analysis tend to coincide and recur. I performed my analysis in an iterative and ongoing process, cycling between literature review, data collection and data analysis.

In order to address what Maxwell (1996) calls "interpretive validity threats" - the possibility that my interpretation of the interview data does not accurately reflect the perspective of participants - my coding was spot checked by other qualitative researchers familiar with the research material. I checked theoretical validity both by looking for discrepant data in existing interviews and by specifically attempting to choose interviews with participants who might contradict my current understanding. As a final, more general validity check, I shared and discussed my general insights with both participants in the field and researchers specializing in qualitative data analysis who were familiar with my data.

4.2 Quantitative Methods

The survey data is drawn from a paper survey the American College of Radiology (ACR) conducted of 3090 radiologists in 2003, including every subspecialty of radiologist. The survey sample was taken from the American Medical Association's (AMA) Master File, a listing of every allopathic physician in the United States, and supplemented by a sample of ninety-two osteopathic radiologists randomly selected by the American Osteopathic College of Radiology

(AOCR) from its list of members.[4] Usable responses were received from 1924 radiologists.

Given my interest in radiologists who could potentially make use of teleradiology applications, I eliminated 119 responses from vascular and interventional radiologists from the analysis. While diagnostic radiologists read and interpret radiological images, interventional radiologists actually perform procedures upon patients. For instance, if a blood clot is discovered in a patient's leg, an interventional radiologist might be called upon to put a filter in the leg. Thus interventional radiologists cannot work from a distance using teleradiology. Excluding them allowed the analysis to focus on the diagnostic radiologists who exemplify the technical and spatial traits in which I am interested.

Eliminating the interventional radiologists left me with a potential sample size of 1805. As with any survey, not every respondent answered every question on the ACR survey -- some questions were left blank or answered incompletely. Roughly 600 observations were eliminated due to incomplete data. In addition to the logistic regression models I present in this paper, I tested a number of subsidiary models, testing for model violations and influential data points. I conducted all regression analysis using SAS 9.1 (SAS Institute Inc., Cary, NC, USA) running on a Windows XP_HOME platform.

5. Findings

Radiologist Control of Teleradiology Use

A priori, one might have expected outpatient physicians to exercise more control than radiologists over the use of information technology to change the space of their work. The

[4] Allopathic medicine refers to conventional western medicine, while osteopathic medicine constitutes an alternative approach founded in the 1890s (Starr 1986).

argument might run that outpatient physicians' work would be much more difficult to relocate, and so they would have more leverage to exert control over their work.

In fact, I found the reverse to be the case. The fact that radiologists have long done their work at a distance from their patients played a key role in shaping the control that they were able to exercise over the use of CMC to change their work. Due in part to their history of working remotely, radiologists were able to use CMC to gain more control over their work, both as individuals exercising additional autonomy in their remote work, and as a profession, exerting control throughout a series of institutions and regulations.

Individual radiologists who work from home appeared to be very different from the disenfranchised and stressed teleworkers that have emerged from past studies of telework (Gurstein 2001). I found that for those radiologists who work from their home, working from afar has led to feelings of additional autonomy. Several nighthawk radiologists cited this sense of autonomy when asked why they chose to start working for a nighthawk firm. One commented,

> It's almost like I'm working for myself. Like I'm self-employed… I'm pretty much just doing my own thing. That's why I started this – a combination of money and lifestyle.

Some of the benefits of autonomy appeared to come directly from the distance from other physicians. Another nighthawk doctor working from home had recently left a partnership under very bitter terms with his former partners. When explaining why he did not mind working nights, he remarked that for him working alone was an advantage. He went on to explain,

> I actually like it. I sit there in my little study. I look out the window at the mountains. I have a little television on in the corner. If I get hungry, I go to the kitchen and make myself a sandwich. I have a weight machine in the basement and I go lift weights if I get tired. It's quite enjoyable. Radiologists are a weird breed. Financially we do well, but it breeds greed. In the hospital everyone can just be trying to work as much as you possibly can. This - you can pace yourself.

The notion of "pacing" himself runs through this passage, as he relishes the ability to eat when he chooses, and to exercise when he chooses. I would propose that their history of working remotely from patients made individual radiologists quicker both to work from home and to assert control over the pacing and content of the work they do at home. They had no difficulty in reconciling this home work with their historic notions of core work.

As a profession, as well, U.S. radiologists have exercised enormous control over the use of teleradiology in general, and nighthawk practices in particular. Despite the apparent dangers of offshoring radiology jobs, currently all nighthawk radiologists who interpret images produced at U.S. facilities are U.S. trained and certified. In addition, the vast majority of nighthawk radiologists, whether located in the United States or abroad, are hired to do preliminary or 'wet' reads only, with their client practices retaining the final or 'dry' read for themselves. Thus, while offshoring remains a possible threat, to date, U.S. radiologists have proven capable of controlling the use of teleradiology in such a way as to minimize the risk of offshoring, as well as to aid them in their struggle with other medical specialties.[5]

U.S. radiologists have exerted this control through a variety of mechanisms, comprising a linked system of formal institutions, informal social norms and radiologist perceptions. One of the most important is the perception that all reads - wet or dry - that inform medical treatment in the United States can legally be done only by radiologists licensed in the state and credentialed in the hospital where they will be informing treatment. While the precise laws governing teleradiology are likely to remain unclear until regulations are rewritten to explicitly incorporate the practice of teleradiology, or until the practice runs afoul of malpractice litigation, participants

[5] See Levy and Goelman (2005) for more on the utility of teleradiology in radiologists' turf battles with other specialties.

widely expressed a belief that all reads that informed medical treatment, *including preliminary or wet reads,* had to be done by radiologists who were licensed in the state and credentialed at the hospital where the treatment was taking place.

These licensing and credentialing requirements effectively prevent foreign trained radiologists from reading U.S. images. Even for a firm employing only United States trained radiologists, the licensing and credentialing process is no small process. A large nighthawk firm must get and keep its radiologists licensed in dozens of states and credentialed at hundreds of hospitals. One of the largest nighthawk firms in the industry, with approximately fifty radiologists, employs fifteen full time employees dedicated only to managing the credentialing and licensing processes. A manager estimated that it took approximately 260 hours, or about six and a half weeks of one non-radiologist employee's work, to get a single radiologist fully licensed and credentialed.

What made it possible for radiologists to exercise control over the use of CMC to offshore their work? It was their core work that was being mediated by teleradiology. Radiologists were able to exert control over the offshoring of their work in part because they had legitimate concerns about quality, quality which they felt uniquely competent to gauge, as it was the focus of their accumulated professional expertise. In controlling the use of teleradiology, radiologists were not only protecting their jobs from offshoring, but protecting their patients from low quality radiology reads. As Grumbach observes, "professionalism developed not just as an anticompetitive strategy, but in response to legitimate societal concerns about competence and quality with an unregulated health care workforce" (2002, 5). Precisely such 'legitimate societal concerns' lent radiologists' efforts to shape the uses of teleradiology the full moral authority and power of their professional status.

Historic spatial practices were important on several levels in shaping this dynamic. The fact that radiologists were accustomed to performing their core work at a distance from their patients meant that they were immediately alive to the potential of CMC use to threaten or improve their work. They saw the computer mediated remote work as their core work, and so, they felt determined to and justified in shaping the use of the enabling technologies.

Additionally, radiologists' history of working at a distance from their patients shaped the very ability to offshore their work. A century of working remotely shaped the sorts of information that radiologists used to do their work. Working at a distance meant that radiologists historically used more limited, and thus more easily digitized, information. As Levy and Murnane (2004 152) have argued, jobs which rely on such information are more likely to lend themselves to relatively easy relocation; such relocation is especially likely given the historic and ongoing decrease in the costs of communication identified by Malone (2004). However the work tasks that radiologists performed with this relocated information continued to be highly complex and uncertain, making it difficult to monitor or measure the performance of foreign radiologists. This uncertainty of outcome, in combination with the easily digitized nature of radiological images, facilitated their ability to play a large role in shaping the use of teleradiology to offshore their work.

Outpatient Physicians Accepting Electronic Medical Records

In contrast to the control exercised by radiologists over teleradiology, outpatient physician participants in this study seemed to accept that the electronic medical records (EMRs) would change their work in ways they could not control. Even at a site where physicians had created the electronic record, they ultimately ceded control to a technology office. One of the record's creators explained, "Basically it was academic physicians wanting to design these

things, and not wanting to continue with the administration of the process." Although the use of EMRs required many outpatient physicians to change their documentation practices in time consuming ways (Goelman 2005b), the changes were seen as sufficiently external to their core work that outpatient physicians appeared both unwilling and unable to resist these changes.

Why did outpatient physicians prove so willing to accommodate their work practices to the EMR? In their seminal work on isomorphist change, Dimaggio and Powell (1983) draw our attention to the particular importance of normative isomorphism in a hospital setting. [6] EMRs were seen as improving patient care, evoking powerful physician norms around providing high quality care. In addition, the transparency of the interface lent the EMR a panoptic quality where any resistance quickly became explicit, and thus, more difficult to sustain (Goelman 2005a). However, providing good patient care is clearly not the only norm that motivates physicians, and it would have appeared to be within their power to resist more than they did. As a technology officer at one clinic explained, doctors often complain to him about the additional time the EMR takes.

> [The doctors] say, 'Listen buddy, I could also be a better husband, I could be a better spouse, I could be a better member of the community. All these people trying to make me better, you're killing me.'

Given the multiplicity of demands on physicians, it is notable that EMRs were so uniformly accepted in the case study clinics. While some participants were initially reluctant to adopt EMRs, they all adopted them within the time limits set out by clinic administrators, and not a single physician quit in protest, nor was asked to leave for non-compliance.

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[6] Dimaggio and Powell understand organizational change and conformity to be driven less by efficiency and more by isomorphist forces. They contrast normative isomorphism - where institutions are driven to become similar by forces such as professional legitimation - to coercive and memetic isomorphism. Under coercive isomorphism, organizations conform due to pressure from organizations on which they depend, while under mimetic isomorphism organizations conform as a means of dealing with uncertain outcomes.

The spatial construction of their core work is useful in explaining outpatient physician acceptance of EMRs. EMR use complements physicians' face-to-face work with their patients by making information more easily available in the disparate office and home locations where physicians might need to access it. While EMR use changes some types of physician documentation and communication tasks, it does not *necessarily* change the dynamic within the exam rooms, as physicians do not have to enter information while they are interacting with their patients (although many do).

In this context, it is useful to compare outpatient physicians' use of e-mail to their use of the EMR. A handful of participants e-mailed their patients without compensation; most, however, chose not to. Increasingly, insurance companies have begun to compensate doctors for their e-mail correspondences with their patients (Kowalczyk 2004; Freudenheim 2005). Why were doctors willing to adopt the EMR, a technology which, like e-mail, required somewhat more time from them, without receiving additional compensation? I would suggest that the asynchronous, remote contact that e-mail provides between patient and physician conflicts with what physicians see as the necessary spatial and temporal bounds on their work, allowing them legitimate grounds to resist using e-mail without compensation.

Several participants made comments to this effect. The physician who instigated Suburban Network's EMR adoption, admitted he had both clinical and financial concerns with the concept of patient e-mail.

> If all the sudden, everybody is e-mailing and not coming to the office, then we may be losing revenue. And we also get a little worried about what people's perceptions would be of what we were do over the e-mail. If everyone suddenly decides they're going to get treated over the e-mail, then we're in trouble.

Other participants were concerned that patients might misuse e-mail in ways that threatened their health. For instance, they might e-mail about symptoms that actually signaled a

medically dangerous event and required immediate attention rather than the delayed response allowed by e-mail. One Urban Central physician remarked:

> My fear has been that patients would use it inappropriately. They will e-mail me when they're sick which is not appropriate. I may not read e-mail routinely or quickly enough… Some days I leave here and I don't have e-mail access until tonight. So it might be five hours. If somebody's calling me on e-mail - or e-mailing me - saying - I had one e-mail 'my lips are swollen up, I took that drug.' I mean, (laughter) you know - that just makes my heart pound. Cause something really bad could happen."

As long as it appeared to participants that EMRs would not fundamentally change what they viewed as their core work – e.g. the work of diagnosing and treating patients - and in fact would improve outcomes, physicians appeared unlikely to raise strong protests to the implementation of the technology, despite privacy concerns.

EMRs were accepted only insofar as they were seen as supporting - or, at worse, extraneous to - the accepted practices around the core work of diagnosing and treating patients. One physician stressed the importance of patients having better access to their information, but then quickly made clear that this was only beneficial when they were reading their information with their physician present. She had recently left a clinic which allowed patients remote access to their medical records and explained,

> I really hated it [the information system]. Patients could see their lab results and you'd get questions like
> 'how come my hematocrit is 39?'[7]
> Well, normal is 39.

She saw giving patients remote access as an invitation for misuse and misunderstanding, increasing stress for the patients and making more work for their doctors.

The administrators / physicians who brought the EMR to their clinics appeared to recognize the necessity of assuring physicians that the EMR would not interfere with their

[7] Hematocrit is a measurement used to test for anemia -- normal results for women range from 35%-48%.

interaction with their patients. They made no mention of physicians concerned about the additional time required by an EMR, but they each addressed at length the charge that using an EMR might detract from the patient-doctor relationship. After acknowledging that one had to be careful not to alienate a patient by staring at the computer too much, one physician who strongly advocated for the implementation of an EMR explained that the computer need not interfere with the patient relationship.

> People know instantly if you care about them. People know right away. Once they know you care, they'll cut you all kind of slack on the little stuff. You don't have to sit there quietly with eye contact for twenty straight minutes. You do have to early on build a relationship.

The administrators involved in implementing the EMR at another site used the EMRs' proven ability to reduce medical errors to convince recalcitrant physicians to document their patient visits on the electronic systems. As the information officer at this site emphasized, "at the end of the day, I wear you [the physician] out on my appeal to you trying to be a better doctor, and make it as efficient as I possibly can."

Spatial Practices Shaping IT Use

In addition to impacting the control each profession exercised in their use of information technologies, spatial practices shaped the very decision to use the information technologies. As described elsewhere (Goelman 2005a), the decision to implement EMRs was strongly influenced by the nature of outpatient physician spatial practices. The spatial nature of outpatient physician core work - face to face meetings in distributed offices - created problems of control and coordination that the EMR was adopted, in part, to mitigate.

For the radiology case, I turn to another aspect of spatial practices: geographic location. Thus far this paper has largely emphasized the proximity aspect of spatial practices. When one compares the spatial practices of outpatient physicians and radiologists, one's attention is

immediately drawn to the aspect of spatial practices having to do with proximity. However, I now turn to the relationship between geographic location and the use of teleradiology.

There are several reasons to believe that geographic location shapes a group's decision both with respect to whether or not to use teleradiology and whether or not to contract with nighthawk practices. For instance, if teleradiology is largely used to compensate for a scarcity of radiologists, it will be used more in those places where radiologists are scarce. One nighthawk executive noted,

> It's hard to recruit to Buffalo, New York. The guys that are retiring, they all want to live in Florida. If they're still working, they want to be somewhere warm, some kind of resort area.

Location might also be significant because small radiology groups in larger metropolitan areas might be able to get serviced by a larger local group with extra capacity. The marketing director at a leading nighthawk firm explained,

> For the most part, smaller communities hospitals in a major metropolitan area can get service by a facility that has a full time radiologist staff that has extra capacity. So you will see those tend to fall under a large facility.

A priori, such reasoning led me to hypothesize that groups outside of large metropolitan areas are more likely to use teleradiology. Radiology groups in a location where radiologists are scarce are presumably more likely to need their radiologists to work nights, a need facilitated by the use of teleradiology between the hospital and the home.

I tested this hypothesis with a series of logistic regression models. Before reporting the results, I present relevant descriptive statistics on teleradiology use and group location. As Table 1.0 demonstrates, by 2003 the use of teleradiology was fairly widespread among American radiologists with 79% of surveyed radiologists using teleradiology in their group. Teleradiology to out-of-group radiologists was much less widespread with only 15% of surveyed radiologists

using it in their group.

This latter figure has almost certainly increased in the two years since the ACR survey was completed. As noted, participants working in nighthawk groups reported a huge upsurge in recent years, with the volume of business increasing by a factor of ten. The three largest nighthawk firms alone now contract to read the night images of over 1000 hospitals - constituting almost 20% of the 5764 hospitals registered with the American Hospital Association in 2003. Dr. James Thrall, the head of radiology in Boston's Massachusetts General Hospital recently estimated that 25-30% of radiology groups currently use outside services to cover off hours (Thompson 2004).

Turning back to the 2003 survey data, one wonders where the radiologists who use teleradiology are located?

*Insert **Table 1.0: Location of Radiology Groups** around here*

It is clear from the outset that the largest plurality of radiologists - just shy of a majority - practice in larger metropolitan areas. Also, one notes that a larger percentage of radiologists outside of cities use both teleradiology in general and teleradiology to out-of-group radiologists. The initial impressions of correlations between the use of teleradiology and city size are largely borne out, as reflected in Table 4.3 below, reporting the results of a series of logistic regression models predicting the probability of using teleradiology.[8]

*Insert **Table 2.0: Logistic regression Predicting the Use of Teleradiology (in general)** around here*

In order to further explicate this model, I present two prototypical fitted logistic curves in figure 1.0 below, plotting the curves only in the ranges where observations exist. As these

[8] While Table 4.1 also appears to hint at a correlation between location and the use of teleradiology to out-of-group radiologists, this apparent correlation disappeared when investigated in a logistic regression controlling for other group variables as well (regressions available from author).

figures demonstrate, larger radiology group and radiology groups outside of metropolitan areas are both significantly more likely to use teleradiology.

-insert ***Figure 1.0: Prototypical fitted logistic curves plotting the probability of using teleradiology versus size of practice*** *around here*

This statistical significance is particularly notable given that the crudeness of the location variable hindered the ability of the model to account for variation in location. The location variable measured only city size, to the exclusion of other aspects of location, such as region. As described earlier, interviews intimated that the region where a radiologist is located would correlate with the use of teleradiology, with groups located in Florida, for instance, thought to have access to relatively more radiologists, and so, to be less likely to use teleradiology. Thus, a more nuanced location variable would presumably have revealed an even stronger correlation between location and teleradiology use.

Reshaping Spatial Practices

A spatial structuring approach suggests that not only do spatial practices shape the use of computer mediated communication, they are also reshaped by its use. This was evident in the ways in which both radiologists and outpatient physicians used information technologies to change their spatial practices at work. In both cases, participants used the respective information technologies to expand the spaces from which they worked. At the same time, however, the iterative nature of the process is clear in the extent to which prior spatial practices continued to exert a strong force on current spatial practices.

The spatial extension enabled by CMC use is particularly clear in radiology. As reported above, almost 80% of U.S. radiologists use some form of teleradiology to interpret images remotely. Nighthawk radiologists can read images from homes and offices located anywhere in

the world with the infrastructure to support a broadband Internet connection. With the spread of broadband this list of locations will soon include remote islands in the Pacific Northwest, as well as practices in Sydney, Australia and Bangalore, India.

Even with these dramatic changes, however, historic spatial practices continued to be influential in determining the particular ways in which CMC was used to change the space of radiology work. While some nighthawk firms utilize an entirely decentralized model spatially, others continue to have all of their radiologists located in one or two central reading rooms. The founder of one of the centralized firms explained that she believes face-to-face contact with other radiologists is important, saying

> Having radiologists reading during the day is a more long term solution. There's a collegiality to the centralized reading room that isn't there when people are doing the interpretations alone from their basement offices.

It seems clear that this founder was influenced by the traditional spatial practice of academic radiology. Many radiology groups at teaching hospitals use precisely such a centralized reading room in order to encourage the learning and collaboration that collocation encourages.

This awareness of past radiology practices also influenced participants at more decentralized firms. They, however, argued that through the judicious use of computer mediated communication they could facilitate the same or better communication as their competitors who collocated radiologists. Their electronic communication systems created a 'virtual reading room'[9] environment which allowed their radiologists to live wherever they want, while communicating throughout their shift using a variant of instant messenger software.

These seemingly disparate spatial models reflect variation in the prior spatial practices of conventional radiology groups. Academic radiology groups have traditionally used more

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[9]The term 'virtual reading room' is service marked by the nighthawk firm, Virtual Radiologic Consultants.

centralized reading rooms, while private groups tend to use a number of smaller reading rooms. The problem with a centralized set up, one private practice radiologist explained, is that:

> One person comes in to chat and everyone stops working. A surgeon comes in to ask another radiologist about an interpretation. Or someone starts talking about the ball game last night. Either way it becomes really hard to concentrate.
>
> The ideal thing is to work like a monk in a cell and just call people when you have a question. But that's not very fun.

In some respects, radiologists working for decentralized nighthawk services work precisely like those sequestered monks to which this radiologist alluded. They work alone for the most part, but when necessary, they consult with others electronically. For instance, asked if he had recently consulted with another radiologist, a U.S. nighthawk radiologist replied, "Sure. All the time. Like yesterday I instant messaged a neuroradiologist in India, and a few minutes after we reached consensus."

The nighthawk radiologists in decentralized practices thus use instant messenger programs, as well as the telephone to complement their use of teleradiology and to compensate for some disadvantages of working remotely. Given the relatively large size of the leading nighthawk firms, the use of CMC allows spatially isolated nighthawk radiologists to actually consult more with other radiologists and have better access to specialist radiologists, than their colleagues in conventional practices, especially those at a small practice taking call at night. Instant messenger is prized for its particular 'not-quite-synchronous' nature. Unlike telephones, instant messenger does not require an immediate response; radiologists need not interrupt their work to answer an IM. However, IM communication tends to be more synchronous than e-mail, satisfying a radiologist's desire for relatively quick consultation about an ambiguous image.

Outpatient physicians, too, used information technologies to reshape their spatial practices at work. EMRs were used to both reinforce existing spatial practices, as well as to

reshape the spatial practices around documentation and communicating with both patients and colleagues.

Outpatient physicians used EMRs to reinforce the existing spatial practice of meeting face-to-face with patients in distributed exam rooms. They still worked in exam rooms face-to-face with patients, but whereas previously they would often have to retake the entire patient history from scratch, the EMR now mitigated that necessity. This was important to physicians, given that patients were seen as unable to reliably remember their medical information.

At two of the three case study clinics, physicians also used the EMR to communicate with other physicians about clients. Communication via the EMR was seen as quicker than phone conversations with no need to wait on hold, and unlike e-mail, these messages were automatically linked to the patient's information, making communication far more complete.

EMR use reinforced and extended outpatient physicians' existing spatial practices around working from home. Prior to the adoption of the EMR, outpatient physicians taking call from had no access to the patient's record from home. The EMR allowed them to verify patient information from home. They also used the EMR to do more patient documentation work from home.

However, at the same time that the use of EMRs expanded the spaces in which physicians could do work, it implicitly constrained the physical ways in which physicians worked in space. The addition of computers to the exam room forcibly limited the variation in documenting patient data; in so doing, it heavily shaped the way that physicians work within the exam room.

While physicians continue to examine their ill patients in person, the introduction of the EMR led many physicians to begin taking notes via the computer. While physicians were not required to document visits on the computer *while* they met with patients, many participants

chose to do so in order to limit the additional documentation work they would have to complete after the appointment. In one case study clinic, the introduction of the EMR coincided with the elimination of a dictation possibility, forcing all doctors to type their notes, whereas earlier they were able to choose between dictating or writing notes by hand. Even in those clinics which retained dictation programs, doctors who had previously hand-written their notes now had to either dictate their notes afterwards or document them on the computer.

Typing notes while meeting with their patients required physicians to sit in a particular location in the exam room and look at the screen as well as at their patient – an arrangement markedly different from the ways in which many physicians previously documented patient visits. These changes were palpably constrained by the results of their past spatial practices: that is, the exam rooms in which they met their patients. These rooms were not changed to make EMR use easier for the physicians. In most cases, a small desk and computer was simply added to the old exam rooms.

Changing the ways that they documented patient information was problematic for many of the participants. At least two participants reported an increase in neck and spine injuries due to the increased time they were spending on the computer. One physician was interviewed while recuperating from neck surgery, the necessity of which he attributed in part to the strain of spending more hours on the computer. He commented

> The intensity [of computer use] was quadrupled. Basically you go into work at 7:30 and you leave at 6:00 and everything is on the computer. Phone messages, flags, prescriptions. Everything is entered into the computer so you're constantly - if you're not doing the physical exam, you're at the computer. It's a sea change. An absolute sea change.

The outpatient participants in this study took very little action to make their work stations more comfortable. When one focus group participant spoke of investing her own money in a

better chair for her office, it elicited chuckles and good natured disparagement from her colleagues. The feeling appeared to be that outpatient physicians were not supposed to spend their shifts at a computer, so there was no point in spending time and money to get comfortable. These feelings persisted despite the fact that outpatient physicians were in fact spending much of their day on the computer. Thus, although the spatial practices with which they performed their core work had effectively changed, their attitude towards communication technology use continued to be largely shaped by their historic spatial practices.

In contrast, nighthawk radiologists who worked from home had put a good deal of thought and expense into making their work stations comfortable, attempting to mitigate the physical intensity of a long session of computer use. Some participants choose to work from a recumbent position, using reclining chairs with lumbar support, along with a foot stool to mitigate the circulation problems attendant with long periods of time sitting. The computer monitors are suspended over such a seat, so the radiologist can lie back as she interprets images, placing as little weight as possible upon her spine.

6. Discussion / Directions for Future Research

This research represents an introductory attempt to formulate a spatial structuring approach and apply it to an empirical investigation of the use of CMC. Several potential expansions of the spatial structuring approach suggest themselves. For the purposes of analytic clarity this paper focused on space to the exclusion of time, but even so, the salience of time repeatedly emerged - as in the analysis of radiologists preferring instant messenger to the phone for its not-quite-synchronous nature or the evidence presented with respect to outpatient physicians' unwillingness to e-mail patients, due to e-mail's asynchronous, remote nature. A comprehensive spatial structuring approach would in fact be a spatial-temporal structuring

approach, one which includes the ramifications of previous temporal practices, as well as previous spatial practices, in shaping and being shaped by the use of communication technologies.

While this paper has focused on control only insofar as it relates to the use of information technology, the changes in both professions also had consequences in terms of control within the workplace. Future research might examine the broader consequences of the spatial dynamics outlined in this paper for relationships of workplace control.

Finally, and most broadly, this approach offers utility to more general analyses of the relationship between CMC and spatial change. Future empirical work on urban and technological change could utilize a spatial structuring approach to link the spatial practices which individuals perform in their daily life and the ways in which CMC is used to change society.

7. Conclusions

The relationship between space and the use of communication and information technologies is a subtle one. In this paper I have argued that a spatial structuring approach allows researchers to move beyond arguments that technology is overcoming space and to focus a more nuanced lens on the multiple interactions between the ways that people work in space and the ways they use communication technologies.

In addition to implications for the use of communication technologies in the work place, there are urban implications to this research. Urban policy makers must better understand the social, temporal and spatial effects of using communication technologies. The ways in which sometimes-teleworkers work in space and time have direct consequences for their families and communities and should be incorporated into community and neighborhood planning.

Additionally, insight into the changing spatial and temporal dynamics of work will better inform our understanding of such urban concerns as the malleability of commuting patterns, the price of urban office space and the use of public space.

Analyses of communication technology and organizations will benefit when space is given more prominence in analyses of social change and communication technology and spatial practices are seen not only as a consequence of communication technology use, but as a predictor as well. Such a shift would help social scientists to better predict the uses of communication technologies, and policy makers to be better able to prepare optimal strategies for dealing with the consequent social and spatial changes.

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Tables and Figures

Table 1.0. Location of Radiology Groups (N=1231)

Location	Percent of total practices*	Percent in location that use teleradiology	Percent in location that use teleradiology to out
Large Metropolitan Area (pop >1,000,000)	47%	75%	12%
Small Metropolitan Area (50,000<pop<1,000,000)	38%	80%	16%
Non-metropolitan Area (pop<50,000)	16%	86%	20%
Entire Sample	100	79%	15%

* Due to rounding this column adds up to 101 %.

Table 2.0: Logistic Regression Model Predicting Probability of Using Teleradiology (N= 1186)

	M0	M1	M2	M3
Intercept	1.33	1.16***	.86***	1.36***
SMALLCITY		0.21	.28~	0.12
NOCITY		.64**	.86***	1.07***
SIZE			.02**	.02**
ACADEMIC				-1.16***
SOLO				-1.92***
LOCUM				-1.72***
GOVERNMENT				-1.06**
Sensitivity (at prob=.60)	0	16.8	32.6	67.9
Specificity (at prob=.60)	100	89.5	75.8	61.1
-2 Log Likelihood	1216.29	1207.83	1178.31	1096.04
Key: ~p<0.10; *p<0.05; **p<0.01; ***p<0.001 (Wald statistics)				

Note:

Reference group is private practice in large metropolitan area. All interactions involving main effects tested and found insignificant.

Figure 1.0: Prototypical fitted logistic curves plotting the probability of using teleradiology versus size of practice