

Material Knowing: The Scaffolding of Human Knowledgeability

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Introduction

In this paper, I want to argue for the importance of considering materiality in our studies of knowledge in organizations. In particular, I want to make the case that our understanding of organizational knowledge, learning, and capabilities is limited to the extent that we disregard or downplay the critical role of material forms, artifacts, spaces, and infrastructures in everyday knowledgeable practice.

I have two aims in this paper: (i) to highlight how and why materiality matters and why we should take it seriously; and (ii) to briefly illustrate how my colleagues and I have been exploring materiality in our studies of knowledge work in our research projects. There are many different ways to address materiality in organizational research, and in suggesting one way that we have found useful I hope to stimulate further ideas and interests in doing this kind of work.

The view of knowledge that I adopt here is a performative, not a representational one. From this perspective, knowledge is not an external, enduring, or essential substance — but a dynamic and ongoing social accomplishment. This is a view of knowing in practice that is receiving much attention by a number of researchers in the field (e.g., Blackler 1995; Lave, 1988; Nicolini, Gherardi, and Yanow, 2003; Tsoukas, 2005). It leads us to focus on knowledge not as static or given, but as a capability produced and reproduced in recurrent social practices.

A practice view of knowledge (Orlikowski, 2002) leads us to understand knowing as *emergent* (arising from everyday activities and thus always “in the making”), *embodied* (as evident in such notions as tacit knowing and experiential learning), and *embedded* (grounded in the situated socio-historic contexts of our lives and work). And to this list I want to add another critical dimension, and that is that knowing is also always *material*.

Everyday practices and the knowing generated as a result is deeply bound up in the material forms, artifacts, spaces, and infrastructures through which humans act. Consider any human action, and then ask about its materiality. Immediately, it becomes apparent that human action is highly dependent on a whole lot of “stuff” — buildings, machines, vehicles, clothes, rooms, desks, chairs, tables, phones, computers, books, paper, pens, and so on — not to mention the “stuff” that is less apparent — air, electricity, water and sewage infrastructures, data and voice networks, and so. On some level, of course, we know this. We know it in our actions. But on another level, the level of conceptualizing and theorizing, we tend to disregard this knowing, and render our accounts of knowledge in organizations without attention to material matters.

I want to claim that not only is human action dependent on such material matters, but that it is constituted by them. Without the material stuff of our everyday lives, human action would not be

possible. That is, practice necessarily entails materiality. And just as materiality is integral to practice, so is it integral to the knowing enacted in practice. Put more simply, knowing is material.

I further want to suggest that this deep intermingling of knowing, practice, and materiality deserves deeper investigation in our studies of organizational knowledge and learning. While material objects and spaces have been part of the organizational knowledge literature for some time, they have tended to be more background than foreground. And with the exception of the important work on boundary objects (e.g., Bechky, 2003a, 2003b; Carlile 2002, 2004; Star and Griesemer, 1989), there has been little explicit theorizing about the role of materiality in knowing. Developing such material accounts of knowing can, I believe, generate valuable insights for our understanding of knowledge, learning, and capabilities in organizations.

Making Sense of Materiality in Knowledge Studies

Our consideration of materiality in the organizational knowledge literature has generally followed the path taken in the organization studies literature where there has been a long-standing focus on technology (Orlikowski and Barley, 2001). This literature can be broadly characterized in terms of two dominant approaches or schools of thought. The first, *techno-centric* approach is interested in understanding how technology leverages human action, taking a largely functional approach and studying technological impacts and effects, tending to assume unproblematically that technology is given, stable, and neutral. The difficulties with this approach are its black-boxing of technological artifacts, its lack of attention to the social character of materiality, and its disregard for the ways in which technology is bound up with political, cultural, and historical influences. The alternative, *human-centered* approach, tends to privilege the social, and is focused on how humans construct, interpret, and use technology in various cultural and historical contexts. Here the technology is problematized; its influence is understood to vary, depending on the different meanings assigned to it, the different ways in which people interact with it, and the different times and places in which it is situated. While this second approach helps to avoid reification of technology, it tends to minimize its materiality, focusing largely on human interpretations and actions. Indeed, as commentators such as Button (1993) and Berg (1997) have argued, the result is that the technology “vanishes” from view in the preoccupation with the social.

The difficulty with both of the dominant approaches to studying technology is that they do not help us understand both the material constitution of the social order and the social constitution of the material world. That is, by privileging either the material or the social, we lose sight of their intermingling. We lose sight of what Pickering (1995, p.15) refers to as “the reciprocal and emergent intertwining of human and material agency.” So the challenge is to develop a vocabulary and set of

understandings that help us speak to the material-social intertwining. As Latour (2004, p. 227) has recently written:

... there exists no relation whatsoever between the material and the social world, because it is the division that is first of all a complete artefact. To abandon the division [...] is to rethink the whole assemblage from top to bottom and from beginning to end.

Much interesting work in this direction has been taking place in the sociology literature, particularly in the studies of science and technology. Concepts such as relational materialism (Law 1992), hybridization (Haraway 1992), actor-network (Callon, 1986; Latour 1992), activity systems (Engeström, Mietinen, and Punamäki, 1999), imbrication (Sassen, 2002), motley (Turnbull, 2000), and mangle (Pickering, 1995) are attempting to directly address this challenge, and break down the conventional distinctions between the social and the material (see, also the 2002 special issue on the Status of the Object in the journal *Theory, Culture and Society* and the 2005 special issue on the Rise of Objects in the Study of Organizations in the journal *Organization*).

This increased attention to the socio-materiality of practice is valuable as it stimulates ways of thinking about and articulating the constitutive materiality of organizational knowing and learning. Drawing on these developments, my colleagues and I have begun exploring the notion of scaffolding and are finding it to be both a powerful and useful metaphor for understanding the material bases of knowledgeable action (Woerner et al., 2005).

Notion of Scaffolding

Scaffolding is a term commonly used in the construction industry to refer to the (usually temporary) structures that support the building or repairing of physical structures. The Oxford English Dictionary provides the following definition:

A temporary platform usually supported on poles or trestles, but occasionally suspended from above, and designed to hold the workers and materials employed in the erection, repair, or decoration of a building.

An examination of physical scaffolds as they are used in the building industry provides some ideas about their distinguishing characteristics. Consideration of these characteristics can offer some intriguing insights into how everyday knowing in practice is materially scaffolded:

- Scaffolds are **temporary** — they are erected on a building site to support the construction of particular elements. They typically exist for the duration of the project (or less), and are dismantled once the elements are completed or self-supporting.
- Scaffolds are **flexible** — they are constructed *in situ*, adapted to fit the particular local conditions; as such, they may be erected in many different situations.
- Scaffolds are **portable** — they are relatively quickly and easily assembled, modified, and disassembled, as needed, on different building sites.

- Scaffolds are **diverse** — there are many different kinds of scaffolds, for example, scaffolds that allow people to walk along the outside of buildings, scaffolds that suspend workers from above, scaffolds that serve as structural columns to hold up slabs until the poured concrete is cured, and scaffolds that serve as reinforcing formwork that then becomes integrated into the final element being built.
- Scaffolds are **heterogeneous** — they are composed of multiple different components, reflecting both the requirements of the element(s) to be supported, and the materials at hand.
- Scaffolds are **emergent** — they are erected over time, changing in form and function, as needed to continue supporting the changing scale and scope of the element(s) being built over time.
- While in place, scaffolds afford a certain temporary **stability** to the disparate assembly of people, materials, and space bound together.
- Scaffolds are **dangerous** — as temporary, emergent, and rapidly constructed assemblages, they are vulnerable to breakdown and failure.¹
- Scaffolds are **generative** — they serve as the basis for other (creative) work, facilitating the performance of activities that would have been impractical without material augmentation.
- They are **constitutive** of both human activity and outcomes, shaping the kind of construction work that is possible, and the construction outcomes that emerge (e.g., scaffolds afford the building of skyscrapers).

Once a building is complete, the scaffolds involved in its construction are no longer useful or required.

The building, however, could not have been built without the scaffolds. Indeed, one can argue that the scaffolds critically structured the production of the building.

Scaffolding has frequently been applied as a metaphor in the sciences, most notably in learning theory and child development by such scholars as Vygotsky (1962 trans.) and Bruner (1990), and more recently in the area of distributed cognition by, among others, Clark (1997, 1998, 2002). In this latter area, Clark (1998, p. 163) offers a general description of scaffolding in human systems:

Scaffolding ... denotes a broad class of physical, cognitive, and social augmentations — augmentations that allow us to achieve some goal that would otherwise be beyond us.

In this sense of augmenting human activity, scaffolds include physical objects, linguistic systems, technological artifacts, spatial contexts, and institutional rules — all of which structure human activity by supporting and guiding it, while at the same time configuring and disciplining it.

In drawing on and applying the metaphor of scaffolding, I want to focus on the provisional scaffolding that is erected by the temporary and situated engagement of technology in knowledgeable activity. That is, for the duration of a particular human practice, actors draw on various artifacts, spaces, and infrastructures to conduct their activities. Once those activities have ended, actors stop engaging with the specific materiality engaged in those activities, and their scaffold is consequently dismantled (just as when a building is completed the scaffold is no longer needed for that purpose, and is consequently dismantled).

¹ Thanks to Chris Sykes for highlighting this important aspect of scaffolding.

In using the metaphor, I want to focus on the “scaffolding of knowledgeable ability” — that is, it is useful to understanding knowing in practice as scaffolded — both culturally (e.g., through codes, language, norms) and materially (e.g., through physical objects, biological structures, spatial contexts, and technological artifacts). I want to focus here particularly, on how knowing in practice is materially scaffolded with technological artifacts. These scaffolds don’t exist outside of knowledgeable human practice; they are “performed” by human agency, and as such, are situated within particular times and locales. Scaffolding is thus constituted “in practice” (Orlikowski, 2000), enacted to accomplish specific human purposes and in doing so, configures particular activities and interactions.

To illustrate some of the potential value of the scaffolding notion to our studies of knowledge in organizations, I want to offer a couple of vignettes drawn from some research studies attempting to take seriously the material entailments of knowledgeable practice.

Illustrations from the Field

My colleagues and I are currently undertaking a research project² where we are examining work and communication practices in a number of field sites. I will draw on two of these studies, sharing data from our observations of and inquiries into actors’ everyday routines. I have selected two different vignettes that suggest some different ways in which the notion of scaffolding allow us to gain insights about knowledgeable practice. The first vignette describes the relatively short-lived micro-interactions occurring among a few managers during a meeting to announce a divisional restructuring; the second vignette describes the longer-term and ongoing communications enacted by client and consultant members of a web-based project team.

Vignette 1: Hardware Inc.

The first example is from Hardware Inc.,³ a Fortune 500, high-tech company specializing in the manufacture and sale of computer and network equipment. Hardware Inc. is headquartered on the West Coast where the majority of its product development and manufacturing sites are located. Hardware Inc. has over 100 field and sales offices in North America and a sales presence in over sixty countries. We have been studying work and communication practices within the company’s Facilities division.

The Facilities division is responsible for most of Hardware Inc.’s physical assets—properties, buildings and furnishings—which are the company’s second largest annual expenditure (employees being the largest). The Facilities division manages its global operations with fewer than 200 employees who are

² The Social and Economic Explorations of Information Technology research project is funded by the National Science Foundation under grant #IIS-0085725 (<http://SeeIT.mit.edu>).

³ Names of all organization, departments, and people have been disguised.

based mainly in North America, with the division's senior management located on the West Coast, and the other personnel distributed across the country, including many contractors.

As part of our field study of the Facilities division (Woerner et al., 2005), we followed two managers (Dick and Jane) who participated in a division-wide, distributed meeting where the newly appointed VP of Facilities presented a reorganization of the division. The following excerpt is taken from our field notes:

Dick and Jane come into the conference room in the Facilities North East building, and sit down at the table. Dick plugs in his laptop computer and tries to get onto the Intranet. He fails to connect to the Ethernet, complains in frustration, reboots his system, and tries again. He gets on.

Dick then turns on the Polycom phone on the table and dials into the conference call. He announces that he and Jane are attending the meeting. The conferencing software connects Dick and Jane, plays a beeping tone so that others know that someone else has checked into the conference, and plays back a recording of Dick saying his and Jane's name.

After people are announced on the conference there is silence except for Charles [the new VP of the Facilities Division, based in California] who is running the meeting, saying hello. Jane has a copy of the new organization chart and checks off people's names as they announce themselves.

Dick and Jane have an agreement that they push the mute button at the beginning of meetings. This allows them to make comments to each other during the meeting; when they want to participate in the discussion they turn the mute off.

Charles announces to the attendees that his presentation is on the corporate server and that they should connect with his administrative assistant, Dorothy, in order to find out how to access the presentation.

Dick accesses his email and sees Dorothy's instructions for how to log onto NetMeeting. He connects into NetMeeting and gets tied into the presentation. He then opens an Instant Messaging window on his laptop [a subset of the meeting attendees are part of Dick's IM "buddy list"].

Charles then begins the meeting. He has control of the screen that displays on the attendees computers and walks through the PowerPoint slides, going through the mission and values of the new organization, and the new assignment of territories among the Facilities Managers.

As Charles goes through his presentation, Dick and Jane start discussing the political implications of the new structure, and what it means for them and their situation in the North East.

At the same time, Dick and Tim [Facility Manager of the South Region] start an IM exchange. One of the strands of their conversation is griping about the reorganization. Another has to do with the territories that each has been assigned in the reorganization. They send messages back and forth about swapping some of their assigned territories. For example, Dick thinks it might make more sense for Tim to have Pennsylvania.

The meeting lasts 45 minutes. Charles does not take a lot of questions, and notes that things like reporting relationships still have to be worked out. He ends the call by announcing that there will be another meeting next week. At the end of the meeting, there are a lot of beeps as people shut off their Polycoms and get off the conference call. There are no goodbyes. Dick unplugs his laptop and his connection to the network, and he and Jane leave the conference room.

As is quite evident from just this simple description, there was an extensive interdependence of human and material performances during this meeting. Indeed, the meeting was constituted not just by the actions and interactions of the human participants, but also by the performances of the various

material elements operating during the meeting. How might we understand this meeting in terms of the interweaving of human and material performances? And how to do so without taking up technological determinism, without taking the technology for granted, and without letting the technology vanish from view. We have found it useful to try and unpack the data of this meeting with some of the ideas about scaffolds.

We can see that the engagement of the participants during the 45 minutes of their meeting was scaffolded by the performance of multiple materialities.⁴ That is, the reorganization meeting relied critically on the material scaffolding afforded by the infrastructure, technologies, and spaces available to the Facilities Division participants. Seeing the meeting as scaffolded, alerts us to a number of things:

- (i) The performativity of the scaffolding was enacted by the human agency that engaged it.
For example, we observe human actors plugging into power plugs, connecting to the corporate Intranet, interacting with Polycom phones, dialing into the conference call, accessing and checking email, launching NetMeeting to display a PowerPoint presentation, activating the Mute Button, engaging in IM exchanges across regions, etc.
- (ii) The human agency was constituted by the performativity of the material scaffolding.
That is, the participation of the actors in this meeting was structured and guided or disciplined by the performances of a range of material elements such as:
 - the size of the conference rooms
 - the speed of the computers and networks
 - the functionality of the conferencing system
 - the availability of the mute button
 - the features of such application software as email, PowerPoint, IM, etc.
- (iii) The performativity of the scaffolding was emergent, unfolding over time.
The performativity of the scaffolding (as constituted by the space, infrastructure and technologies) unfolded over time, on as-needed basis, for example, the use of IM during the presentation to informally negotiate reassignments, the use of the mute button to allow alternation between private and public talk.
- (iv) The performativity of the material scaffolding was temporary.
That is, the space, infrastructure, and various technologies operating during the 45-minute meeting were disconnected, closed, or “vacated” at the end of it.
- (v) The scaffolding bound together a heterogeneous assembly of people, places, and things, thus affording them a temporary stability.
That is, the participants included the VP of Facilities and various regional managers, located in six distributed locations and spread over three time zones, interacting via the activation of a number of infrastructural (networks, computers, phones) elements, and textual (presentation, messages, interactions) ones.
- (vi) The performativity of the scaffolding entailed a range of cultural, political, personal, and institutional relationships.

⁴ Of course, action prior to and after the meeting was also scaffolded by various materialities, but for the purpose of this vignette, I will focus primarily on the duration of the meeting.

For example, the hierarchical relationship between Charles (the VP) and the other participants was both evident in and enacted through his control of content and delivery of the PowerPoint presentation (via NetMeeting); the relationship between Dick and Jane was manifested in and reinforced by their face-to-face, private talk which they managed through the available mute button; and Dick and Ted's professional ties were visible in and shaped by their IM exchange that allowed them to work around the authority of Charles' formally assigned regional boundaries and orchestrate an informal redrawing of such boundaries (a negotiation that was politically risky but not culturally proscribed).

- (vii) The outcomes of the meeting emerged from the situated entanglement of human agency and material performativity.

That is, the quality of the meeting was shaped by the form and functioning of the interoperating materials (e.g., power, networks, telephones, computers, email, IM, mute button), and when and how the agents (e.g., Dick, Jane, Tim, Charles, etc.) engaged with them.

Quite simply, the knowledgeable practice of the participants in this distributed meeting would not have been possible without the material scaffolding temporally erected by them.

Vignette 2: Adweb

Let me turn now to my second illustration. It is drawn from our field study of an end-to-end interactive marketing company, Adweb, which develops websites for a range of organizational clients. Since its founding as a dotcom in 1995, Adweb had experienced rapid growth, and at the time of our study it employed 650 people worldwide, with offices across the United States and Europe. Adweb operated in a highly uncertain, rapidly changing, and very competitive environment. Over the years, clients had started to demand more integrated services to help them deal with the advent of electronic commerce.

Work at Adweb was carried out in temporary, self-organizing and cross-functional teams and their everyday work included developing and selling concepts and designs, building websites, and coordinating extensively, both internally on their cross-functional teams and with their clients. We were interested in understanding how Adweb members accomplished their cross-boundary knowledgeable work in conditions of high speed, uncertainty, and rapid change (Kellogg et al. forthcoming). We found that Adweb members' team coordination was scaffolded by a range of material performances, including infrastructural and architectural technologies (e.g., power, networks, open plan office), computing hardware (e.g., personal desktop computers, laptops, cellphones, the office server, wireless and wired networks), and software (e.g., email, PowerPoint, Excel, Calendaring, the firm Intranet, and various client Extranets).

Let me focus in on one specific technology, Extranets, that afforded the interaction between clients and Adweb team members. Extranets are a common technology employed by firms to communicate with clients. Adweb was no exception and over the years, as the demand for faster and more integrated web solutions increased, the frequency, type, and extent of interaction with clients on the

Extranet had increased dramatically. Adweb sets up an Extranet with every client on every project team, and most of the communication about the project is posted there daily. This provides a space—both physical and virtual—where team members can communicate and share ideas with their clients.

The performativity of the Extranets extended interaction between Adweb members and clients *in real time*. This allowed rapid and apparently constant interaction with clients wherever they might be in time and place (what some referred to as “a 24x7 connection”). As one Adweb member observed:

There'll be a client who's located in Geneva ... [and he is] constantly traveling across Frankfurt, London, New York. And oftentimes, I don't even have a clue [where he is] but he's looking at the Extranet. Clients know that everything is always on the Extranet. So that as soon as they know there is a [teleconference] meeting, they will automatically go to the Extranet, log on, and the most recent version of the document will be up there on it.

The performativity of the Extranets extends interaction between Adweb members and clients *over time*. That is, it constituted a historical archive that documented activities, interactions, and decisions on the project, and was used to keep people “in the know,” as one member explained:

Every piece of documentation, the notes from every meeting, any deliverables that we have on the project, any design (if we're doing any creative and exploratory work), etc. Absolutely every deliverable and everything is on this Extranet. It's a good archive of everything that's going on in the project.

But there are consequences to such constant communication, such as increased visibility. The performativity of the Extranets increased visibility and review of project work for the Adweb team. That is, the Extranet, while it provided a common platform for displaying and storing ideas, information and work in progress, also made such information more visible and open to accumulation, reuse, scrutiny, evaluation, and critique. An Adweb member commented:

[Everything] is highly visible and always looked at ... You need to tolerate a higher level of critique and review. ... In the mainframe environment you could control your information. The whole notion that you can control information to maintain a position of power is gone now.

The performativity of the Extranets increased the engagement of clients, but it also increased Adweb's dependence on them. That is, Extranets afford an increased reliance on clients, as the nature of the relationship enacted via the Extranet entailed inviting and receiving feedback from the client. Because feedback was solicited, it needed to be both awaited and acted on. This introduced both delays and risks:

In this new environment there is a lot more risk because of the level of detail we get into with the client project team. ... [We now have] two masters at the client: the IT department and the Marketing department. We are co-dependent with their team.

The action of Adweb's team members working on projects with their clients was scaffolded by the performativity of Extranets that made their work in progress, designs, plans, code, schedules, specifications, and documentation common and visible to the team as well as the client. The performance of the Extranets also extended the reach of the Adweb team temporally and geographically, as it allowed

client members to access the materials posted to the Extranet at any time of the day and from multiple locations around the world. This facilitated increased communication between Adweb team members and client members, creating opportunities for the sharing of data and the receiving of feedback on a more continuous basis.

Seeing the interaction of Adweb teams and clients as scaffolded allows us to focus on the changes in work and communication afforded by the material performativity of the Extranet technology. In particular, we observed the following:

- shifts in the everyday work of Adweb members towards more representations, reviews, and revisions;
- shifts in the knowing in practice generated and reinforced on Adweb project teams towards more emergent, provisional, dynamic, and contested forms of knowledgeability;
- shifts in relations between Adweb and clients towards a kind of distributed co-production — a regime of work that distributes knowledge and responsibility across multiple players, moving power away from consultants and towards clients who are more engaged, integrated, and invested in project outcomes.

Scaffolded interaction on Adweb project team thus creates a platform for different (more ongoing and more emergent) ways of engaging with clients, generating different forms of dependence, innovation, and accountability in consultant-client relationships.

Scaffolding Knowing in Practice

To reiterate and summarize, I want to suggest that the notion of scaffolding may be both a useful and powerful lens for producing insights into how the materiality of infrastructures, spaces, and technological artifacts structure human agency (and thus knowledgeability) over time. Specifically, and drawing on the vignettes sketched above, we can begin to see how the material performativity of the scaffolds erected in the two sites shaped practice through the following:

- *Extension.* Scaffolding extended human agency across space (different geographic locations) and time (both contemporaneously across time zones, as well as historically over time).
- *Complement.* Scaffolding complemented human agency by performing work that was difficult or tedious for humans to do (e.g., maintaining an indexed archive of project documentation in one place, or allowing quick sorting and searching of information in digital databases)
- *Linkage.* Scaffolding connected human agency through linking humans to each other (e.g., on a teleconference call or IM exchange) as well as humans to artifacts (e.g., PowerPoint presentations, databases, websites, email, etc.).
- *Stabilization.* Scaffolding stabilized the dynamic interaction of humans (with each other and with artifacts). For example, the Extranets on Adweb project teams serve to hold together the constantly changing and heterogeneous data, requirements, plans, and designs of the project work, creating a kind of platform that serves as a provisionally and temporarily stable reference point guiding and disciplining activities for the time of the project.

- *Reconfiguration*. Scaffolding facilitated an alignment or realignment of relationships. For example, the use of IM during the Facilities teleconference enabled the informal and real-time negotiation of regions by managers, thus undermining the legitimacy of the Facilities VP, even as he was trying to assert his new hierarchical authority.
- *Transformation*. Scaffolding transformed human agency, in the sense that it is evident that the scaffolded human agency was different from the human agency that would have been performed without it. The relationship between the material performativity of scaffolding and human agency is constitutive, reciprocal, and recursive.

To end, I believe studies of knowing would be enhanced considerably if we come to see knowing not only as emergent, embedded, and embodied, but also as materially *entangled* — to use Woolgar’s (2002, p. 265) term. That is, human knowledgeability is inextricably entangled with materiality. And it seems to me that not only is this critically important to understanding knowing in organizations today, but that it will become even more so as our lives become increasingly scaffolded by virtual, tailorable, and taken-for-granted objects and contexts. As the deep intermingling of materiality in practice continues apace with artifacts such as embedded intelligence, software agents, social tagging, and monitoring systems, new conceptual tools and insights are required to adequately address and understand their implications for organizational knowledgeability.

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