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Designing Collaborative Infrastructures to Support Distributed Work

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Abstract

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Keywords: Boundary objects, collaborative infrastructure, discourse, language-games

DESIGNING COLLABORATIVE INFRASTRUCTURES TO SUPPORT DISTRIBUTED WORK

Research-in-Progress

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A growing proportion of contemporary organizational work takes place in the context of distributed collaborative environments which involve the interaction of multiple organizations with distinct areas of expertise, technologies, and work practices. In this research-in-progress, we develop a three-part model of the facets of collaborative infrastructure that support such distributed collaborative environments. We argue that collaborative infrastructures inherently reflect the interplay of practices, artifacts, and discourse. Specifically, our model asserts that the development of shared practices and artifacts by organizations engaged in collaboration is mediated by the emergence of common discourses between the parties. The preliminary theorizing developed in this paper is based on multiple case study analyses of collaborative projects in the areas of architecture, engineering, and construction (AEC) and software development and implementation. Our initial research suggests key areas of consideration by collaboration leaders in the development of collaborative infrastructures for distributed work.

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1. Introduction

A growing proportion of contemporary organizational work takes place in the context of distributed collaborative environments (Armstrong and Cole 2002, Montoya-Weiss et al. 2001, Weisband 2002). Such environments are the locus of exchange for multiple teams or organizations that have different areas of expertise, employ different technologies, rely on different managerial and work practices, and speak different professional languages. Furthermore, their activities are often mediated through geographical or conceptual distances, time, collective resources, and heterogeneous experiences (Turner et al. 2006). Nonetheless, these organizations have to maintain effective cross-boundary communication channels and coordinate their activities in order to achieve common or highly-interdependent tasks.

Distributed collaborative environments are becoming increasingly commonplace as a result of the proliferation of global supply chains (Neubert et al. 2004), networked and virtual organizations (Powell et al. 2004), and distributed information technologies (Briggs et al. 2003). Examples of distributed collaborative environments include software development projects where clients, vendors, and consulting organizations collaborate to design software products; the construction industry where multiple engineering, construction, and architecture firms join forces to design and construct buildings; and the airline industry where multiple design and engineering firms, spread across multiple global locations, cooperate to design and fabricate aircrafts. In addition, many areas of scientific research reflect distributed collaborative environments as researchers collaborate with colleagues across professional disciplines, institutional boundaries, and technological platforms to carry out collaborative work.

The drivers of, and impediments to, the accomplishment of collaborative work have been studied extensively. Much of the work in this area has focused on the role of joint practices in enabling heterogeneous organizations to collaborate effectively. For example, drawing on Bourdieu's (1977) practice theory, Levina and Vaast (2008) argue that differences in practice may give rise to boundaries between members of distributed teams and consequently become obstacles in achieving effective collaboration. Other studies have focused on discourse or socio-cognitive processes and their importance in enabling effective mutual work. For instance, Grant et al.

(2005a) proposed that collaboration results from ongoing conversations among participants. Through conversations participants discursively construct a collective identity which enables effective collaboration and synergetic action. Yet another strand of research has emphasized the role of shared objects in facilitating collaborative work. Drawing on Star and Griesemer's (1989) notion of boundary objects, numerous studies have demonstrated the effectiveness of various artifacts in fostering mutual understandings and joint action among heterogeneous groups (e.g., Carlile 2002, Gal et al. 2008).

Despite the contribution of these works, an integrative framework that explores the interrelationships of practices, discourse, and artifacts, and that captures the way that they jointly enable collaborative work is missing from the literature. Such a framework is needed because in real life situations we simultaneously draw on practical, discursive, and physical resources to establish collaborative relationships: we cast meaning into joint objects through discursive activities; we use objects to support and anchor shared practices; and we develop and enact a collective discourse in concrete physical and practical inter-organizational settings.

This research aims to fill the gap in the literature by presenting the concept of *collaborative infrastructure*. Our primary argument is that in order to successfully achieve distributed collaboration requires developing and enacting a collaborative infrastructure. This infrastructure consists of three inter-related elements: First, a set of *practices* that are enacted by organizational members either in relation to or in common with the practices that are enacted by members of other collaborating organizations. Second, a repertoire of *discursive (linguistic) resources* that consist of representations of various work domains that pertain to the collaborative effort and that are developed reciprocally and used by members of the collaborating organizations. Finally, they entail a body of joint *artifacts*. These are objects that are shared by multiple organizations, inform different practices, and acquire different meanings in different locations.

The three infrastructural elements are interdependent in that one cannot be enacted in isolation from the others. Therefore, to understand and facilitate collaborative relationships requires understanding not only the three elements, but also their interrelationships. In this paper, we seek to develop a number of propositions as to the composition of collaborative infrastructures as well as to the nature and structure of the relationships among their three constituting elements.

2. Elements of collaborative infrastructures

2.1 Practices

Practice has long been recognized as a key factor in establishing collaborative relationships in distributed work settings (Carlile 2004, Levina and Vaast 2008, Walsham 2002). A basic assumption guiding this work is that the development of cross-boundary practices will help participants see beyond their immediate local contexts and enable them to develop a broader understanding of their environment. However, establishing shared practices that cut across multiple contexts is not a trivial endeavor. Practices evolve out of the ongoing interactions among actors in concrete situations. Thus, situated practices emerge in a local environment and in relation to the particular idiosyncrasies that characterize that environment.

Whereas plans for action might exist in documents, blueprints, or designated strategies, people often improvise and change those plans according to the specific demands of the situation in which they are acting. Because practices unfold as people adapt to changing local circumstances, they require a deep familiarity with that particular environment and necessarily entail knowledge that is inherent in the actions of individuals (Schön 1983). This sort of 'knowing' is an ongoing social accomplishment that is continually constituted in everyday practice (Orlikowski 2002); knowledge "does not exist as well-defined bodies in the form of rules or abstract models with intrinsic features. A body of knowledge cannot be understood in and of itself, allowing it to be transferred unchanged from one context to another, without changes to its properties… knowing… [is] constructed by relations among people engaged in an activity" (Østerlund and Carlile 2005). A similar observation about the enacted knowing that underlies practice was made by Giddens (1986) who maintained that "the knowledgeability incorporated in the practical activities which make up the bulk of daily life is a constitutive feature… of the social world. What is known about the social world by its constituent actors is not separate from their world" (p. 90).

Giddens too recognized the local nature of knowledgeable practices and claimed that there exist potential differences in the rules and tactics of practical conduct across different social situations. The extent to which an individual's social skills allow "immediate ease in culturally alien settings is obviously variable – as, of course, is the meshing of different forms of convention expressing divergent boundaries between cultures of societies" (Giddens 1986: 91).

Practice can thus be said to be communal in nature in that becoming a knowledgeable practitioner means gaining recognition as a legitimate member of a community. In other words, the process of becoming a part of a community is the process of gradually taking part in a set of practices that are shared by community members (Lave and Wenger 1991). New arrivals start by participating in a few simple activities that are peripheral to the core functioning of the community. Over time, through their engagement in a growing number of activities, they become proficient in accomplishing more of the community's practices and accepted as indispensible members (Lave and Wenger 1991).

Two types of inter-organizational practices are worth noting: joint and reciprocal practices. *Joint practices* are carried out in common by members of multiple organizations. For example, a meeting on a construction site among engineers, designers, and contractors where they discuss the fabrication and installation of a certain element of a building. *Reciprocal practices* are carried out in reference to practices that take place in neighboring organizations but do not necessarily involve unmediated inter-organizational interactions. These can include cross-organizational hand-off processes, procedures for communication and exchange of information, and routines for reporting across organizational boundaries. Drawing again on the context of architecture and construction, the exchange of blueprints and other design documents represents a case of reciprocal practice.

In the course of constituting and reconstituting communal practices, actors are engaged in shaping fields of practice (Bourdieu 1977). These fields grow out of mutual interactions among actors who share common goals and interests, and who develop agreed upon criteria to assess social capital (Levina and Vaast 2008). Because of the unique nature of practices and social capital that characterize each field of practice, distinct fields are separated by practice-based boundaries (Bourdieu 1977). Therefore, the challenge of developing inter-organizational practices is a challenge of transcending practice-based boundaries and local knowing. To do so requires interactions among the members of the participating parties and involves communication among the individuals involved.

2.2 Discourse

In the past 20 years, organizational research has experienced a surge in studies on the role of communication and language in creating and maintaining organizational identities and practices (Alvesson and Kärreman 2000, Deetz 2003). This so-called "linguistic turn" centers on the concept that organizations (and indeed all social institutions) come into existence through interpersonal discourse – i.e., acts of talking, writing, and other forms of communicative action that result in the creation and distribution of texts (Grant et al. 2005b). This increased interest in a linguistic emphasis has engendered a range of novel analytical methodologies, including discourse analysis and conversation analysis (Phillips and Hardy 2002, Silverman 1993).

The linguistic turn in organizational research is deeply grounded in the understanding of reality as socially constructed (Berger and Luckmann 1966). In the social constructivist perspective, our experience of social phenomena is given material reality through discursive interactions with others (Grant et al. 2005b). Thus, language is the medium through which our experiences achieve meaning. This view stands in stark contrast to the traditional understanding of social reality in which language is assumed to play a referential role (Alvesson and Kärreman 2000). That is, in the conventional framing, language is understood to correspond to, or define, elements of a pre-existing external reality in which meanings are uncontested (Mauws and Phillips 1995).

Much of the social constructivist perspective on reality and the role of discourse in its formation traces its origin to the latter work of Wittgenstein (2009). Of particular interest to us is Wittgenstein's concept of the "language-game" as the primary unit of interpersonal discourse. For Wittgenstein, words are given meaning through the specific discursive context (i.e., language-game) in which they are applied, rather than their referential power to an existing reality (Astley and Zammuto 1992). Language-games produced through repeated interactions between individuals in a given context establish the rules for what constitutes legitimate statements and truth claims. This emphasis on context is reflected in Wittgenstein's (2009) assertion that distinct language-games serve to bound particular 'forms of life': "The word 'language-game' is used here to emphasize the fact that the *speaking* of language is part of an activity, or of a form of life" (p. 15). Thus, language-games define the specific discursive contexts in which they are employed.

The concept of language-games as constitutive of bounded modes of social discourse has significant implications for our understanding of inter-organizational collaboration. From this perspective, an organization is comprised of a unique set of discourses that delineate its relevant forms of life. As Ford (1999) has observed of conversations (i.e., distinct discursive exchanges): "Within a conversational context, organizations can be understood as networks of conversations constituting a variety of first and second-order realities. That is, organizations *are* networks of conversations rather than *have* networks of conversations. Conversations are and provide the very texture of organizations." (p. 485; emphasis in original)

Thus, an organization is nothing more and nothing less than the discourses which its members enact, and these discourses are bounded by the historical and interpersonal contexts in which they were developed. Turning our consideration to efforts at inter-organizational exchange and collaboration, we discover that such undertakings necessitate the confluence of distinct sets of discourses. In such an exchange, there is no unambiguous criteria for legitimacy of one organization's language-games vis-à-vis that of the other (Mauws and Phillips 1995). As a result, the potential for real collaboration requires either the recruitment of one entity to the accepted language-games of the other or the formation of novel discursive forms of life amongst all parties.

2.3 Artifacts

Objects are central to most distributed collaborative work. From mundane artifacts such as office furniture and cars, to more sophisticated instruments such as production machines and different types of information technologies, objects constitute the physical backbone upon which collaborative relationships are formed. However, establishing the common use of objects across multiple communities can be a daunting task.

Most objects are designed to meet the requirements of certain communities. Having to address issues and deal with problems that are specific to their unique circumstances, different communities (e.g., an organizational team or a social community) design and fashion the tools that they believe are best suited to help them function effectively in their social and physical environments using the resources that they have at their disposal. For example, in the context of information systems development (ISD), systems analysts and software engineers have developed a variety of formal information models (e.g., use case models, entity-relationship diagrams, data flow diagrams) that enable the community to marry the ambiguities of an application domain and user requirements with the need for clarity and consistency in support downstream development activities. Yet outside of the ISD environment, these models lack a clear meaning or simple applicability.

Of course, in an era of increasing globalization, the majority of objects are mass-produced to be distributed to, and used by, people in different countries and cultures. However, even then different communities can find ways to customize the artifacts that they use and accommodate them to their unique physical and cultural requirements. Returning to the ISD context, we encounter cultural differences in the application of information modeling techniques and development tools between developers from different countries (Sarker and Sahay 2002). Similarly, in the context of architecture and construction, cultural differences exist in the use of design tools and the sequencing of associated design activities (O'Brien et al. 2003). For a more mundane example, while cabs are used worldwide, most British cabs have a unique design feature: an unusually small turning cycle of only 25 feet. One of the reasons for this is the small roundabout in front of the famous Savoy hotel in London. The size of the roundabout requires that vehicles need the small turning cycle to navigate it. That requirement later became the legally required turning cycles for all London cabs (wikipedia.org).

In addition to their physical characteristics, many objects embody cultural features and are imbued with symbolic meanings that can have strong communal connotations. For example, flags are highly symbolic in nature. A flag represents the history, values, and identity of a community and serves as a common reference point for community members around which they can express their similarities, common aspirations, and kinship. A case in point is the flag of the Soviet Union which had a red background color, a hammer crossed with a sickle, and a single star. The red color of the flag symbolized the blood that had been spilled by workers and farmers. The hammer and sickle signified the nation's workers and peasants, while the star represented the ruling of the communist party. Thus, the different elements of the flag represented the core tenets of Soviet communism.

In terms of their symbolic nature and amenability to multiple unique customizations, most objects can be said to be inherently local. However, to establish collaborative relationships across communal or organizational boundaries requires some common application of objects. Some authors have suggested that boundary objects can be particularly helpful in bridging differences across multiple communities and contexts and in facilitating collaborative work. Boundary objects are artifacts that reside in the interfaces among organizations. On the one hand they are flexible enough to contain varying meanings which arise from the multiple organizations that use them. On the other hand they are robust enough to serve as a common reference point to members of multiple organizations when they engage in mutual practice. This duality enables multiple organizations to collaborate without having to develop or agree on a shared set of specific definitions of their situation and tasks (Star and Griesemer 1989).

Although they have been shown to support knowledge sharing (Carlile 2002), inter-communal learning (Wenger 2000), and various forms of collaborative work (e.g., Gal et al. 2008, Horton and Wood-Harper 2006, Yakura 2002), the interrelationships of boundary objects with the discourses that characterize the collaborating communities and the practices that these communities rely on to carry out their work have yet to be examined.

To address this gap we next introduce a conceptual model that captures the relationships among objects, discourses, and practices.

3. A framework of collaborative infrastructures

To understand and facilitate collaborative work in distributed settings requires attention to the three challenges that we have discussed. That is, the formation of distributed collaborative environments necessitates the creation of shared practices, the development of mutually-accepted discourses, and production of boundary objects. While several existing theories – including activity theory (Vygotsky 1987), actor network theory (Latour 1987), and the theory of distributed cognition (Hutchins 1995) – have drawn upon one or more of these facets, we contend that a fully integrative framing of these three foundations has yet to be proffered.

Importantly, we argue that it is impossible to address any one (or two) of these three elements in isolation, because they are fundamentally intertwined. The enactment of most viable interpersonal relationships in general, and of distributed collaboration in particular, involves drawing on practical, discursive, and material resources simultaneously. We engage collaboratively with others most effectively when we have a common language (i.e., we understand what others mean), when there are procedures to organize and regulate our interactions, and when these interactions are mediated and supported by objects.

However, these three elements are interconnected such that understanding and enacting each can only be achieved by considering it in relation to the others. This requires adopting a holistic lens and exploring the nature of the relationships among practices, discourses, and artifacts. The present research focuses on just such a holistic framing. Specifically, we argue that the formation and attribution of meaning to both practices and artifacts is mediated by the organizational discourses in which they are steeped. Moreover, the formation of collaborative infrastructure to support inter-organizational exchange requires the creation of shared practices and artifacts through the emergence of common modes of discourse. Our model of interaction between the practical, artificial, and discursive facets of organizational life is presented in Figure 1.

Within our model, discourse plays a central role in mediating the interactions of practices and artifacts. As we have noted, a social constructivist perspective suggests that, in their essence, organizations are collects of shared discourses or language-games.
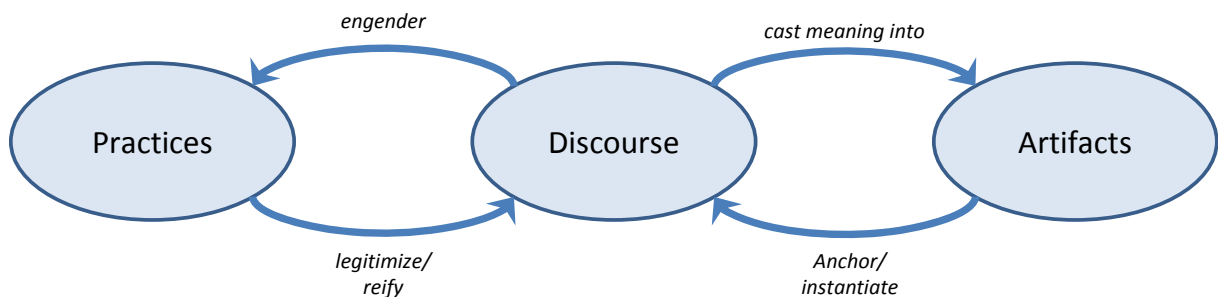

Figure 1. The Three-Facet Model of Organizational Life

3.1 Relationship between discourse and artifacts

The adoption and appropriation of novel artifacts within an organization is achieved through discourses which *cast meaning into* the relevant artifacts. Thus, two ostensibly identical artifacts employed by distinct organizations are likely to be understood as two different objects, because the organizational discourses that give them meaning are distinct. For example, two identical vendor-supplied enterprise resource planning (ERP) systems implemented in two different organizations may be indistinguishable with respect to the functionality that they provide. Yet, the uniqueness of the discursive conventions governing their adoption means that their use and the validity of truth claims that they support will be markedly different in the implementing organizations.

Importantly, the influence between discourses and artifacts is not unidirectional. Once entered into and given meaning within an organizational discourse, artifacts are drawn on by members to instantiate and *anchor* that very discourse. Continuing the previous example, in their conversations and in making organizational decisions, members may use information generated by the ERP system, apply linguistic conventions that the system

employs, and adopt classification schemes that the system uses. In this way, the ERP system serves as a reference point to anchor organizational discourse and render it more concrete.

3.2 Relationship between discourse and practices

A similar pattern of interactions can be observed in the development and enactment of organizational practices. Such practices come into being, or are *engendered*, through the linguistic/textual interactions (i.e., discourses) of the organization's members. Consider the function of human resource (HR) management as an example of this dynamic. Such common HR-related practices as employee onboarding, personnel training, performance appraisal, and the structuring of incentives are the products of organizational discourses around the role of employees, the authority of managers, and the values and goals of the organization. No two organizations are identical in this regard because of the localized nature of the relevant discourses. Accordingly, to understand organizational practices and their significance to local actors requires recognizing the discourses that underlie these actors' activities and interactions.

While practices are engendered by discourses, once institutionalized they can serve to *legitimize* the very discourses that facilitated their inception. For instance, when asked to explain the rationale behind certain organizational policies (e.g., around the distribution of resources, or the structuring of incentive systems), managers often resort to the existence of formal organizational practices as a means of justification. In other words, the logic of certain organizational discourses can be explained by the existence of the practices by which they are executed. The more institutionalized and embedded in an organization's history a practice is, the more effective it will be in *reifying* an organizational discourse.

4. Designing collaborative infrastructures

Given the nature of the relationships we have discussed, designing collaborative infrastructures requires considering the primary role that discourse plays in both the development of organizational practices and the attribution of meaning to artifacts. Therefore, discourse is a natural starting point for assessing infrastructural design issues.

Discursive exchange between collaborating parties can be fostered through the development of open forums for discussion and sharing of perspectives. Importantly, such forums need not be structured around the specific elements of collaboration between the collaborating parties. Rather, forums are intended as a way for members of the distinct organizations to engage each other in open conversations through which the beginnings of commonly-held modes of discourse can emerge, and upon which later practical and artificial forms of collaboration will be based. The research on virtual teaming offers several insights in this regard. While some researchers argue that face-to-face communication is not absolutely necessary for the effective functioning of a distributed team (Poole and Zhang 2005, Walther 1993, Walther 1996), the bulk of the research on virtual teams advocates the use of face-to-face communication to build social relationships between group members (Armstrong and Cole 2002b, Jarvenpaa and Leidner 1999, Maznevski and Chudoba 2000, Poole and Zhang 2005). This is especially critical at the inception of a group when social bonds drive the creation of a shared identity and discourses. Thus, in the beginning of a collaborative effort, opportunities for face-to-face discursive exchange should be enabled to the degree possible. Fortunately, developments in video telepresence (e.g., Allan 2008, Nakanishi et al. 2009) have made such face-to-face exchanges feasible even in geographically distributed contexts. Again, this exchange need not be strictly task-focused, because the development of social bonds helps to reinforce the cohesion of a group and leads to improved collaborative outcomes (Knoll and Jarvenpaa 1998, Panteli 2004, Poole and Zhang 2005). Accordingly, collaborative parties should maintain some tolerance for general social interaction.

While a task orientation is not the sole objective in discursive exchanges within newly-formed collaborative relationships, these exchanges should incorporate concepts that represent the various application domains that are relevant to the collaborative effort. Moreover, these concepts should be devised such that members of all the collaborative parties can relate them to (i.e., render them meaningful in) the context of their local language-games. It should be noted that because of its highly abstract nature, discourse is particularly difficult to intentionally manipulate. Therefore, the process of consumption and internalization of new concepts by the collaborating parties is likely to be precarious and lengthy.

One way to support this discursive integration is by fostering a collective hermeneutic process (Hansen and Rennecker 2010). In this process, participants engage in directed discussions concerning novel linguistic terms in a collaborative exploration of their meaning. For instance, participants in a multi-organizational software development project could address such questions as: "What do we mean by 'criteria'?"; "When do we want to use the word 'compatible' as opposed to 'conformant'?"; and "What counts as a 'bug'?" (Hansen and

Rennecker 2010). This type of collective hermeneutic process could be facilitated through the use of various artifacts, most notably online collaborative platforms such as groupware forums (Boland and Tenkasi 1995, Ellis et al. 1991) or wiki environments (Leuf and Cunningham 2001, Souzis 2005).

The outcome of the collective hermeneutic process should be a collection of definitions, categories, and interpretations that are shared by the collaborating parties. Two comments are in order here. First, that the hermeneutic process should produce outcomes does not imply its finality. In fact, the process recurs in a cyclical manner and the resultant interpretations are continually revised. Indeed, following Gadamer's (2004) model of interpretation, this continuous revision is inevitable in the hermeneutic process: "Understanding is not merely a reproductive but always a productive activity as well . . . It is enough to say that we understand in a different way, if we understand at all" (p. 296). Second, by "shared" interpretations we do not mean to imply that members of different organizations hold *identical* understandings of certain concepts. Rather, the concepts act as common reference points that are recognizable to all participants and that mediate their communication. However, the meaning that they hold for the different participants may vary.

The development of new modes of collaborative discourse makes certain paths for the development of shared practices more salient. For example, once the parties have agreed on the meaning of such terms as "efficient collaboration," "inter-organizational accountability," and "successful outcomes," they are likely to be able to engender mutual practices that reflect these agreed-upon notions. Thus, if the parties agree that inter-organizational accountability requires regular reporting across organizational boundaries, they should develop the practical mechanisms to ensure that such reporting takes place. Once in place and in regular use, the reporting practices can be used to justify and solidify the legitimacy of their underlying discourse in case it is challenged.

With respect to the nature of practices that can support distributed collaborative efforts, the literature on distributed work is again informative. For example, the evidence suggests that dedicated scheduling of interactions and the creation of formal agendas for communication sessions makes distributed interaction more predictable and manageable (Maznevski and Chudoba 2000). In addition, collaborating organizations may benefit from relatively detailed task decomposition and the establishment and enforcement of explicit timelines for specific tasks (Armstrong and Cole 2002). By breaking tasks into smaller components and communicating more frequently, distributed parties can greatly reduce the potential for large surprises and the vulnerability to practice-based failures.

The promotion of frequent communication means that practical norms of rapid response may be required in collaborative efforts. For example, Jarvenpaa and Leidner (1999) found that initiative-taking (e.g., volunteering to complete a given task) on the part of distributed project stakeholders serves to engender greater trust among other participants. However, such initiative requires rapid response from fellow stakeholders for it to persist. Citing Hawisher and Moran (1993), Jarvenpaa and Leinder (1999) observe: "Because computer mediated communication entails greater uncertainty than face-to-face communication, there tends to be an 'intense need for response'" (p. 811). This finding suggests that distributed collaborative stakeholders may benefit from relatively rigorous norms for response times to the queries or statements of others.

The recognition of the role that computer-mediated forms of communication play in distributed collaborations turns our attention to the facet of artifacts. The emergence of a collaborative discourse highlights the prominence of certain artifacts and induces participants to use them as boundary objects. For example, if the discourse developed by the collaborating parties depicts their relationships in formal terms, then a formal, legal contract that delineates areas of responsibilities, expected deliverables, and inter-organizational communication channels is likely to become a meaningful artifact in mediating the parties' relationships. Such contracts frequently function as critical boundary objects in collaborative efforts (Carlile 2002, Gal et al. 2008). When used regularly over a period of time, participants are likely to draw on the contract and on the provisions that it contains (e.g., distinction among different organizational functions and their role in the collaborative effort, assignment of liability in different situations) in discussions with their counterparts. In this way, the contract serves to anchor inter-organizational discourse and render it more concrete.

Another key class of boundary objects in such collaborative efforts is the suite of information and communication technologies (ICTs) employed. Much of the early research on distributed collaboration focused on a relatively small number of enabling ICTs – e.g., email, telephone, and videoconferencing. Several additional media are now relevant in the consideration of distributed collaborative infrastructure. Instant messaging, virtual collaborative workspaces, electronic whiteboards, workflow management software, and mobile computing devices have the potential to greatly expand the range of communication and collaboration options open to distributed parties (Bafoutsou and Mentzas 2002, Olson et al. 2002). Organizations undertaking a distributed collaboration must determine what combination of technological resources might fit the nature of their work. Such a determination would reflect the adoption of what Nardi and Whittaker (2002) have called a

'media ecologies' perspective, in which teams employ "an appropriate mix of face-to-face and other media depending on the work, its temporal sequence, the context, and the distances to be traveled" (p. 102).

The determination of collaborative media offers an excellent illustration of the way in which collaborative practices and artifacts are bound together by discourse. The parties to a distributed collaborative effort must be explicit about their expectations with respect to the modes of communication employed by the group (Poole and Zhang 2005). What media (i.e., artifacts) will be used for which activities (i.e., practices) is arrived at through open discourse between the collaborating participants. For example, stakeholders may favor email or online collaborative workspaces for the exchange of shared documents (i.e., boundary objects) while opting for the telephone or instant messaging for short communications or those with significant urgency. The point is that such issues are best addressed before the task work of the collaboration gets underway. Similarly, the practices through which stakeholders will collaborate in the creation of shared deliverables (again, boundary objects) must be discussed overtly. Norms of communication can (and likely will) change over time as the stakeholders continue to develop the discourses/language-games that bound the collaboration, but establishing a baseline understanding between participants will help to avoid uncertainty during the early phases of collaborative activity.

5. Concluding Thoughts: Research-in-Progress and Future Research

The preceding discussion reflects the focus of our current research-in-progress. Specifically, the theoretical framework that we have outlined reflects preliminary findings from the study of multiple inter-organizational collaborations in two distinct design environments: 1) projects in the Architecture, Engineering, and Construction (AEC) industry and 2) software development and implementation projects. We have incorporated multiple design contexts in an effort to foster external validity and to address threats to the internal validity of the research.

For the present research, we have adopted a multiple case study research methodology. The multiple case approach is employed to engage in a rich exploration of inter-organizational projects for theory generation, refinement, and validation related to the creation of distributed collaborative infrastructures (Eisenhardt 1989, Yin 2009). The unit of analysis for the multi-case data collection is the individual design project. The case inquiries were conducted in accordance with prevailing case study field procedures, including the development of a case study protocol prior to data collection, triangulation using multiple sources of evidence, and the maintenance of a chain of evidence (Yin 2009). For all projects, the data collection effort included interviews, direct observation of project interactions, and documentary review. Interview transcripts, observational field notes, and documentary evidence are being coded using Atlas.ti, a qualitative analysis tool. The coding is centered on a thematic analysis of the case study data (Boyatzis 1998). While we are conducting the thematic analysis in line with key principles of grounded theory methodology (Glaser and Strauss 1967, Strauss and Corbin 1990), such as constant comparison and open, axial, and selective coding, it differs from a pure grounded theory approach in that the analysis is informed by existing theoretical frameworks (e.g., boundary objects, discourse theory).

Preliminary coding has focused on the identification of themes (i.e., patterns and concepts) within the data around the infrastructural elements that support inter-organizational collaboration. However, as data analysis is in-progress, additional codes will be developed as they are identified in the coding process. This code generation will proceed until the researchers deem that theoretical saturation has been achieved (Eisenhardt 1989; Glaser and Strauss 1967). All data sources (e.g., interview transcripts, field notes) will be iteratively coded as the final coding structure emerges.

Thus, the current data analysis focuses on the generation and validation of theory grounded by an explicit pragmatic emphasis on the challenges and demands of practicing design collaborations. By focusing on actual inter-organizational projects, we seek to develop theoretical insights that can be applied in other collaborative environments. Thus, we anticipate a range of additional research that will flow from this preliminary study. In particular, we envision that additional research will focus on the creation of enhanced tools and infrastructural components to support inter-organizational collaborations.

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