The Management of Distributed Organizational Knowledge

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Abstract

This paper presents findings from a longitudinal field study examining the problems of managing and transferring local knowledge beyond the specific context and workgroup in which the context and rules for that knowledge are understood. The ways in which a collaborative group managed and communicated local knowledge, translated across organizational boundaries are described. The findings demonstrate a fundamental contradiction between the situated, distributed nature of collaborative knowledge processes and the expectation that software systems will provide codified knowledge. A model is presented that demonstrates a shift from individual knowledge to design knowledge, focusing on the dominant modes of knowledge deployment at different stages of design emergence. The role of specific representational genres, in mobilizing a move from one mode of knowledge-manipulation to another may be significant in boundary-spanning design.

1. Introduction

The most commonly held view in the organizational knowledge management (KM) literature is that there is a hierarchy in which data, information and knowledge incrementally build on each other, to construct the basis for human action [1]. In its search for understanding of how knowledge can be "managed", the organizational KM literature has especially focused on the difference between tacit and explicit knowledge, comparing "know how" (tacit knowledge) with "know what" (explicit information) [18]. Thus, organizational KM is perceived as problematic because of the difficulty in supporting processes that are largely tacit with information systems that require the formalization and codification of explicit rules by which to process and present data. This is particularly problematic when cooperation is required for the completion of work-tasks across organizational boundaries.

This paper examines the performance of cooperative design from a KM perspective. It presents a case study of a group of managers engaged in the high-level co-design of business processes and IT systems for an internal business process that spanned organizational boundaries: responding to customer invitations to bid for new business. This study examines the problems faced by the group, in determining what knowledge was appropriate for the process and how this would be supported by information sources within the company, when knowledge of the process was distributed across a wide number of people and work-domains.

2. Conceptual Background

There is a fundamental contradiction between the two streams of "knowledge management" theory reflected in the IS literature. From the organizational KM literature, it would appear that knowledge processes are embedded within a localized context. These depend on an understanding of the social and cultural rules of behavior in a specific group, performing specific work, in a specific place (a community of practice) [1, 3, 11]. But the successful use of information and computer technologies to communicate knowledge among distributed workgroups depends on knowledge being captured, codified, and transferred between people located in many *different* places and between *different* communities of practice [3, 12, 27, 28]. It is complex and difficult to transfer this type of "situated" knowledge beyond the specific context and workgroup in which the historical practice and rules for that knowledge are understood. The role of the knowledge worker is to engage in reflective activity, through which "know how" (tacit, skill-based) knowledge is produced [15, 21]. Organizational knowledge management lies at the intersection between explicit rules and procedures and tacit interpretations of a socially-constructed "world" [15, 29].

An alternative stream of theory focuses on "Knowledge-Based Systems" (KBS) [7, 13, 14, 20]. In

this stream of the literature, knowledge itself is reified - detached from the context of its application and the individual within whose head it resides [4]. This is an intended outcome, so that knowledge may be codified to form the basis of computer data-processing systems [4, 7, 20]. From this perspective, knowledge exists in *external*, real-world structures and relationships. The role of the knowledge worker is to perceive these structures and act upon them, embedding them into plans and generalizable actions [1, 14, 22]. The end result is a privileging of explicit knowledge over tacit knowledge [4, 5].

The difference between the two perspectives lies not in the end but in the means. Both streams of research aim to "manage" information. But there are fundamental differences in the ways that each perspective deems appropriate to achieve this. While much of the organizational KM literature seeks to use computerized information systems (IS) as a tool to support locally-situated human work, the KBS literature focuses on IS as a system of control. The rule-based emphasis that underlies the KBS perspective leads to a focus on process consistency and the reduction of decision-making variance in human beings. Humans are seen as sources of error that must be controlled [19]. The two KM perspectives become muddled and applied interchangeably, so that the varying discourses of intent remain unexamined [22, 27]. This is particularly true in organizational practice - the real world, practical applications of IS to support KM. As Prusak [18] observes, the quality movement has been at the center of much real-world organizational KM and this element is expected to grow in importance. With the consequent focus on instrumentality and measurable outcomes [18], the objectives of IS in organizational practice often remain unexamined. Holsapple and Joshi [8] performed a Delphi study of practicing knowledge managers, to elicit those factors that most affect how organizational actors use knowledge in their work. Their framework emphasizes a *balance* between managerial influences, resource influences and environmental influences [8].

What we refer to as "organizational knowledge" is often distributed across a community of professional practice and thus only partly understood by individuals [9, 11, 25]. An understanding of a joint activity is distributed between, or "stretched over" [25] members of a collaborative work-group. This implies an overlap, rather than a congruence of individual knowledge about what to do:

> "Distributed cognition is the process whereby individuals who act autonomously within a decision domain make interpretations of their situation and exchange them with others with whom they have interdependencies so that each may act with an understanding of their own situation and that of others." [2, page 457]

Distributed knowledge may be coordinated across the boundaries of different work (or knowledge) domains through the use of "boundary-objects" [25] that signify a common concept, design, or a state in a distributed task. For example, IT developers use data-flow diagrams and process-flowcharts as a way of communicating the internal logic of their design. Another developer does not have to understand the application domain to understand the logic represented by such boundary objects: they mediate meaning across knowledge domains. But representations that are meaningful to members of one community of professional practice are meaningless to members of a different community (for example, asking the average IT system client to judge a set of requirements by validating a data-flow diagram).

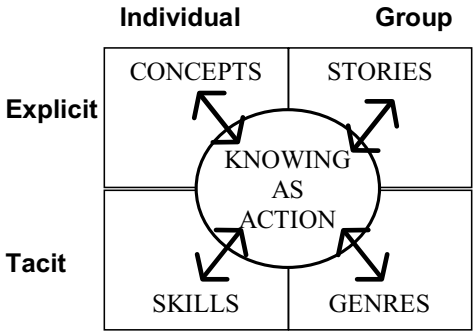

Figure 1: Adding knowing to knowledge (adapted from [adapted from 5])

So we have a tension in boundary-spanning group work, between the expectation that collaborative groups share knowledge of the task in hand and the understanding that boundary-spanning work involves the merging of individuals' partial knowledge of the task in hand, deriving from different work-domains. Cook and Brown [5] argue that four different forms of knowledge must be shared for effective, collaborative "knowing" to take place, as shown in Figure 1. This framework was selected as the basis for this case study analysis as it represents an epistemology of the different ways of knowing, that interact to produce organizational "knowledge". Because of this, it allows us to address areas not covered well by much of the existing KM literature, that tends to focus on either the explicit codification and transfer or the implicit acquisition and modification of organizational knowledge.

The top-left quartile of the [5] framework represents things an individual can know learn and express explicitly – the individual "know what" category of knowledge that provides rules and explicit procedures that may be codified to provide the basis of computerized information system processes [5]. This is the type of knowledge that is most often privileged in

the KBS literature: individual knowledge that is possessed and is articulable and therefore easiest to externalize [15]. This type of knowledge is expressed through *concepts*: things an individual can express about what they know [5].

The top-right quartile of the framework represents the explicit sharing of knowledge between members of a workgroup, through the expression of what is known, collectively. Again, such knowledge is articulable, reflecting a collective "know what" definition of knowledge. This type of knowledge represents accepted or legitimate practice for a specific social community or workgroup [5, 11]. *Stories* are typically used as a way for sociocultural communities of practice to express collective memory of success or failure. For example, Pettigrew [17], explains how ICI developed a shared work culture through the sharing of mythic stories about the feats of its new chairman in achieving radical change.

The bottom-left quartile represents knowledge acquired through "productive inquiry" [6], "reflective action"[21], or experiential learning [10]. Dewey [6] argues that knowing is something that we do, not something that we possess. *Skills* are tacit knowledge that represent individual "know how" rather than "know what" [5, 11]. We express this type of knowing through skillful action [5], so we must reflect on our own work practices and why we do things in a certain way, to understand what we know [10, 15, 21].

The bottom-right quartile represents the shared conventions, norms and social practices that permit us to make sense of the world in a distinct way and that signal our membership of a specific community of professional practice [5, 11]. The use of specific *genres* signifies deep social meaning, that allows us to take cognitive shortcuts in determining what to do in organizational situations. Genres are "socially constructed, interpretive conventions that bridge the two sides of communication" [3]. Such conventions represent a collective form of "know how", that is inscribed into organizational forms through the use of a specific language, visual representation, or medium of communication [3, 11, 30]. Genres derive from the ways in which influential organizational actors manage the meaning of work and of organization, for others [17, 24]. Thus, genres cannot be considered independently of the political context within which knowledge is constructed. A genre is "enacted through rules, which associate appropriate elements of form and substance with certain recurrent situations" [30, page 302]. An examination of the dominant genres of communication thus allows us to understand the ways in which groups form and reinforce definitions of "legitimate" knowledge within a local practice.

By focusing on each of the four categories of organizational "knowing", we may examine the ways in which knowledge is expressed and "managed" in the context of organizational work. In the case study that follows, we examine how a collaborative group employs their own language, genres and culture to mediate and give meaning to local knowledge and how this is mediated across organizational knowledge-domains.

3. Research context and method

3.1. Organizational background of study

NTEL Ltd.[1] is a mid-sized engineering firm in the UK, specializing in the design, manufacture and sale of products to the telecommunications industry. The subject of this research was a group of managers engaged in the design of business process change and IT systems support, to improve the customer bid response process. NTEL felt that they were losing business to competitors because of poor responses to customer invitations to bid for new business. A potential customer invited a number of suppliers to submit a Bid for a customer project, detailing how each supplier proposed to fulfill the customer's requirements and at what price. Preparation of this document was performed by a loosely-associated group of people, assembled on an ad hoc basis from the main areas of the business. Functional delegates would work on an individual section of the Bid response document for a few days or weeks until it was ready to be dispatched. Problems with the current Bid response process could be classified into four areas: (i) coordination of a team people who worked for different managers with different priorities, (ii) bid response quality (information accuracy and consistency between sections prepared by different people), (iii) crisis management, due to the short notice at which invitations to bid were received, (iv) information management, when bid response preparation depended upon local knowledge.

The design group was led by the IS Manager and the Process Improvement Manager, who reported to the company Board of Directors. Other group members represented each of the main divisions of the company: marketing, finance, engineering, operations and commerce. Each of these divisions was involved in the business process to be redesigned (the Bid process) and all of the design group members had personal experience of participating in the Bid process. The design group membership was thus intended to

[1] Names of the organization, its departments, members and products have all been disguised.

represent knowledge derived from all areas of organizational work and also to represent the interests of the various political groups involved in the process being redesigned.

3.2. Research method

A longitudinal field study was conducted using an interpretive, ethnographic approach to data collection and analysis [23, 26]. Data collection was performed via three means:

1. Participant observation of a boundary-spanning design group. Approximately half of the design meetings were observed and tape-recorded, over an eighteen month period. Group members reported on events between meetings, or external to the design group in informal discussions. Formal and informal project documents were also collected.
2. Semi-structured interviews with members of the core design group, at the beginning, halfway through and towards the end of the design project.
3. Group workshops were held, halfway through the study and following its end, to understand what individual group members and the group as a whole "knew" about the design. The second workshop provided validation of the findings and additional insights from the group.

Data were analyzed initially through a thematic coding [16, 26] of categories of knowledge employed by the design group. This analysis used the group's own definition of six design episodes, based on a top-down, decompositional model of the design process. Three major themes emerged:

1. A mismatch between the expectation that the high-level design of organizational processes and IT systems would be a top-down process, relying on shared knowledge, and the emergent, distributed nature of design goals, problems and solutions.
2. The conflict between explicit and tacit organizational knowledge, leading to a collective difficulty in discriminating between significant and insignificant design information.
3. The relationship between individual domain expertise, influence and the design group focus at different points in the design process.

An exploration of these themes suggested the framework provided by Cook and Brown [5] and discussed above, as an analytical structure. A secondary analysis was performed, analyzing the role played by the four forms of knowledge: concepts, skills, stores/metaphors and genres. This analysis revealed a different view of the design process, that resulted in the definition of four stages. Each stage appeared to be guided by the different ways in which knowledge creation and sharing supported the emergent process of boundary-spanning collaboration.

The four stage model of the design process, together with the expertise-led stage framework suggested in the discussion at the end of this paper were presented to design group participants in a workshop at the end of the study. There was a high level of agreement with the four stage definitions and group members suggested additional insights validating the framework which were subsequently incorporated into the detailed findings. The transition between these stages appeared to be guided by a shift in the group's tacit valuation of specific knowledge domains at any point in the design process. A shift in valuing certain types of knowledge appeared to lead to a shift in design focus by the group. The nature of this shift in knowledge valuation is explored further in the discussion following presentation of the case study findings.

4. Case study findings

4.1. Stage A: Defining design objectives

At the beginning of the project, group discussions focused mainly on the objectives of the design. Objectives to be achieved by the new information system differed radically for individual group members. Differences in perspective appeared to stem from each individual's work-background, as reflected by one participant's assessments of his fellow group members:

> The Customer Solutions Manager comes at it from a reasonably broad experience in industry. How the hell he packs his understanding of the way business ticks in his young head, I have no idea … he has been mind-blowing, and I've constantly underestimated his capacity to contribute, but … I've seen him very much as a pragmatist, speaking from experience and a practical understanding of the way things tick, with a very high degree of vision.
> … I expected the Bid Manager to be a lot more open minded and to demonstrate a lot more vision than he has. He has turned out through this exercise to be extremely protective of the status quo … and I think, really, the only conflicts that come out within the group … were because of his protectivism.

Different team members were perceived as possessing specific domain expertise and their ability to influence fellow team members appeared to depend upon whether the group prioritized the knowledge associated with that domain of expertise. In the following meeting extract, the Bid Manager redefines the set of information that other group members have just determined is required for a bid response by calling upon his expertise in managing the *existing* process:

> *Bid Manager:* These [information flows] are not part of the process; these are just inputs to the process.

Customer Solutions Manager: Yes, but we need these pieces of information to put the Bid together, so producing them is part of the process.

Bid Manager: No it's not. Mike doesn't produce these costings; Geoff does. It's not part of the estimating process, its part of product engineering process, so this is nothing to do with us.

Customer Solutions Manager: But if we need this information to produce the Bid, then it is part of our process.

Bid Manager: No, I disagree. This is nothing to do with bidding. The output from this is: this is the price we're going to charge the customer. That's the output. There are lots of inputs to make that decision. But the process is still getting the information, doing your juggling with the figures and coming up with the answer.

Initially, using different representations of the design was an explicit project objective. The co-design of business and IT systems was a new initiative for this company and they wished to experiment with appropriate forms that the process should take. Individual group members were encouraged to use a variety of design representations. The early stages saw different individuals produce Pareto charts, organizational charts, information-flow diagrams, "knowledge-component diagrams" (a way of showing the knowledge components that fed into a decision), and many other forms of representation. The type of representation used appeared to depend strongly on their domain background. These representations appeared to be associated with different definitions of what the design (and its associated organizational change) was intended to achieve.

Different group members were very well aware that they defined design objectives differently, to the extent that managing conflict in dialogues was an explicit part of design meeting interactions - group members often prefaced contributions with comments such as "I know [individual] won't agree with me, but …" or "I understand where you're coming from, but I don't agree with you because …". While these debates appeared generally good-humored and led to richer conceptualizations of the target system, the IS Manager (who was leading the project) saw the existence of multiple design perspectives as problematic:

> The big problem is, everyone's got their own ideas about what it should do and how it should work. What we need is to agree on a common vision as early as possible, not to complicate things with even more disagreements. You tell me how you can get seven people around a table to agree on what they're doing, if they're all drawing different pictures of what they want to get out of it.

Because of this concern, the IS Manager suggested that the group use process flowcharts to achieve a "common vision of the design". Other group members deferred to his extensive experience of managing IS design and the group as a whole engaged in a training session, to learn how to produce and understand process flowcharts. But different group members interpreted the purpose and content of the process flowcharts very differently, depending upon their work-background (even towards the end of the project, misunderstandings would arise from the way in which these models were interpreted). A wide variety of representations continued to be used, as the group appeared to find it helpful to take different views of the design problem domain. The two individuals who were most influential in group discussions at this time (determined from an analysis of how disagreements were resolved) were the IS Manager and the Customer Solutions Manager. Other group members appeared to defer to them, because they were perceived as possessing the widest scope of knowledge about how the organization worked and so could bring the most innovative perspectives to the redesign of this, core business process.

4.2. Stage B: Determining an appropriate design process

Towards the middle of the project, group members appeared to adopt a position that they were there to learn from each other and so they deferred to other people who understood various areas of process operation. There were still disagreements between group members, but these tended to be about the information required by the system, or the processes by which external information was generated, rather than about the purpose and nature of the system.

The Project Engineering Manager was "intellectually excited by the design process", to the extent that he was prepared to spend a great deal of additional effort in acquiring the application-domain knowledge and expertise necessary for him to conceptualize the process, in all its complexity. This led him to propose a new approach to design. Each member of the group would take responsibility for defining a sub-process - a paper prototype of the design - which would be presented to the group for critique and modification. This approach soon became known across the group as a whole as the "Aunt Sally" approach: the name derives from a fairground game, where a wooden doll is knocked from a stand using sticks or balls. The new approach allowed each person to present their knowledge of that part of the bid process of which they had prior experience to the others. This gave the group a conceptual starting-point, from which they could add to or modified a representation of explicit knowledge, supplementing this with exemplars that communicated tacit knowledge. The group were now able to pool very incomplete knowledge of how the current bid process worked, or could work. The IS Manager commented:

> I think everyone was more than happy with the Project Engineering Manager doing the bulk of the work (laughing). … my view is that the quality of the 'Aunt Sally' has been

better for stages one and four than it has been for stage two which was done by committee.

The group emphasis now shifted to an investigation of what individual knowledge was required to participate in preparation of a bid response and how the formal information system could capture this, so that such knowledge could be shared. So issues of "know-how" now became significant, rather than "know-what". This distinction exerted itself in two ways. Firstly, the know-how that was most valued by the group was the ability to perform design. Most group members were aware of the need for change to the bid process. But they lacked the skills to define what needed to change. So they relied on those members of the group who had prior experience of design: the IS Manager and the Project Engineering Manager. This resulted in some conflict between the two individuals, as each attempted to guide the process according to their domain-based knowledge of how design should proceed. The IS Manager attempted to standardize the process, by insisting that all design representations should use a common format (process flowcharts, accompanied by a formal text specification of the process). The Project Engineering Manager disagreed, attempting to introduce information-flow representations as a core representation, as his experience warned him that existing process tasks and mechanisms were not sufficiently understood for a new process to be defined:

IS Manager: I would feel a lot more comfortable with a little more structure in the text against each box. If, in each box, if it said: owner, input, process, outputs, rather than a more ad hoc, textual, “this is what happens here” then I would feel that it was a bit more usable into the long term.

Project Engineering Manager: you normally work it the other way round. You say ‘what am I asked for’, ‘how am I going to do it’, ‘who do I need to do it’ and ‘what [information] do I need in to me to achieve it’?

The IS Manager won this debate, because he was in charge of the project and so able to explicitly define legitimate forms of knowledge that were acceptable at various meetings. In particular, he enforced the genre of "what, not how", calling on a formal training in business process redesign methods, to deter decisions concerning organizational responsibility that degenerated into political debates. Avoiding "the specter of organization” became a common metaphor in group design discussions - individuals would catch themselves, halfway through a description of a suggested process, with the words "I'm raising the specter of organization again, aren't I?".

4.3. Stage C: Expanding the design boundary

The Board of Directors had authorized the project on the promise of "quick wins": rapid benefits to the company, delivered through the identification of inefficiencies and problems in the existing process that could be amended by work-reorganization or the provision of more targeted information. But, to quote the IS manager: "the outcomes of this project were neither winning nor quick". As the design proceeded and the group began to develop a more extensive shared model of how the process worked and how this fitted into the wider set of organizational and business processes, their vision of change became more systemic. They began to perceive the interrelatedness of the bid process with various other business processes with which the bid process interacted. However, this "systemic" knowledge was not perceived as legitimate, as it conflicted with their politically-constrained agreed boundary for the system design. It was also contentious as the Marketing division representative on the group - the Customer Solutions Manager - had left the company and had not been replaced, as the Marketing Director was hostile to any changes to his area of responsibility. So not only did the group lack detailed knowledge of areas that they needed to change, but they also lacked a political advocate for this change in the Marketing division. The only access which the group had to Marketing work-processes was to the documents produced as output from those processes. The group spent many hours attempting to understand, at second hand, actual and potential information-flows within the company, based on these documents. They worked in a "gray area" of knowledge, that attempted to make sense of processes that were not legitimate targets of the design, but that were tacitly recognized as necessary for the design to be effective, as shown in Figure 2.

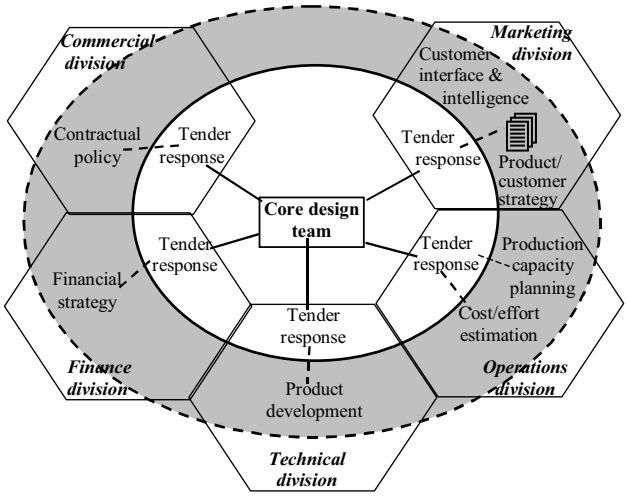

Figure 2: Explicit system boundary *(solid line)* vs. implicit system boundary *(dotted line)*

The impact of the expanding nature of the implicit system boundary (shown as the gray area in Figure 2) was emergent and slow to be realized. The design group started to define "interfaces" to the formal system boundary. Explicitly these were document or information requirements at the interface to their system, but these were not represented as information-flows. The group created a new process flowchart symbol - a hexagonal box - to represent a tacit meaning of "interface": changes required to an external process. They invited people from outside the group to present on various aspects of organizational processes that interfaced with their own process and which they needed to affect. But as this was not a legitimate scope for the design, external experts were often invited secretly and asked to talk through scenarios for how they performed their work.

The group wrestled with many process changes that lay outside of the explicit system boundary, which they could not legitimately define or investigate, as demonstrated by this meeting extract:

Project Engineering Manager: So what we need is a short-form document to hack the MSOR [a document produced by the Marketing division, external to the Bid process].

Process Improvement Manager: If it's product driven, won't it come through the Invitation to Bid document?

Project Engineering Manager: No, it will always come through the MSOR. This filtering process is appropriate to stage 4 as this process will be drawn upon from other routes and other processes.

Bid Manager: So what you want at the top of stage 4 is "strip and allocate MSOR"? [this comment implies a fundamental change to Marketing work procedures].

Process Improvement Manager: I'm not sure that we can do that.

The IS Manager ended this dispute with the words "the reason we're struggling because we're trying to look at it in process terms whereas it's really information flow that we're trying to reflect round that feedback loop". But it was unrealistic for the group to learn another representational method. The IS Manager eventually came up with a resolution: he redefined the bid process as a component of the wider, business and product planning processes in the company. This legitimized the need for formal documentation of business and product lifecycle information and it legitimized the need for the design group to understand strategic business processes (which had formerly been politically unacceptable). In this way, without extending the explicit system boundary, the IS Manager and then the group as a whole made the implicit system boundary explicit to the design group. Soon, the IS Manager was encouraging the Project Engineering Manager to reintroduce his information flow diagrams (similar to data-flow diagrams, but conceived at a higher level of modeling document generation and flows of knowledge between business processes). The group managed the dual nature of the system boundary by inscribing this boundary implicitly in definitions of formal document contents. While they could not redefine the processes that produced these documents, they redefined them indirectly through a redefinition of the document contents.

4.4. Stage D: Working towards design closure

The group was under pressure to complete the design. The project had initially been planned to take three to six months. It had lasted for over fifteen months at the start of this stage. The Board of Directors were questioning the expected benefits. Many of the organizational staff involved in bid response, who had participated in "pilot" studies of the new system, were adopting and promoting the changes in an ad hoc and partial way. The group needed to deliver benefits and was afraid that the benefits would be perceived as "business as usual" by the time that the project completed. So they adopted a satisficing approach to project completion, focusing on instrumentality, rather than perfection. This led them to value expertise that would help them to complete the project rapidly. Two different types of expertise were identified as most influential in driving group decision-making because of this. The IS Manager and the Project Engineering Manager were each influential because they had prior experience in design project completion. But most influential in this process - to the frequently-expressed chagrin of the IS Manager - was the Bid Manager. The Bid Manager understood how the current process worked. He could therefore define parts of the process that no-one understood, or over which there was a lot of disagreement. The Project Engineering Manager was frustrated that so many radical changes were being lost in the rush to closure and the lack of any mechanism to capture individuals' knowledge of process mechanisms that were being delegated to others, but could do nothing in the rush to deliver the design.

It became clear that none of the group understood the bid response process as a whole. Though modeling information-flows, the group had started to derive an extremely complex model of the bid response process. This was difficult for one person to comprehend in its entirety. Group-members agreed that they could not possibly define all of the information and knowledge required to support the new process. So they started to redefine what should be in a "document repository" to support a set of areas of the bid response process that were not well-defined. In this way, they subsumed the definition of the *formal* knowledge required to prepare a bid response into the definition of a system that would store company documents -- and thus support

informal knowledge processes -- and a limited set of codified knowledge (such as historical cost estimates).

There was a certain spirit of bravado engendered by the feeling that this was an appropriate point for the group to tackle "the specter of organization". The Process Improvement Manager stated that "it's courage in our hands time". But there was also a tacit recognition that none of the radical change that the group wished for could happen without the cooperation of the Marketing division. This was not forthcoming. So the group appeared to compromise their objectives. Project closure was achieved in a rush of delegation. The group identified a set of tasks that needed to be completed, for the project to deliver the intended benefits. Individuals who had knowledge or expertise in various areas of the work required were delegated to perform this work. A need to "train the troops" was identified, so the Process Improvement Manager was delegated to take charge of this element. A need to define the detailed information requirements for each part of the new process was identified, to ensure that the IT systems contained appropriate documents, so the IS Manager was delegated to take charge of this work. A need to define improved task allocation processes was defined, so the Bid Manager was delegated to take charge of this work. It was noticeable that the group resolved their earlier problems with distributed knowledge by now abdicating responsibility for achieving a common vision of the design. It is also significant that the IT system became invisible to the project group from this point on. Its detailed specification was delegated to the system development group for them to define the detailed information and knowledge to be stored in the document repository.

5. Discussion

The use of the four categories of knowledge in analyzing a group design process over time provided insights into the nature of the process that a less guided thematic analysis could not. Interactions between explicit and tacit forms of knowledge and the ways devised by the group to deal with a gradual understanding that distributed design knowledge was too complex to be shared in entirety, reveal the nature of organizationally-situated IS design. There was a constant tension within the design group, between viewing the design process as *pooling existing* individual knowledge of the organization and viewing design as a process of *collective learning* about how organizational processes functioned. Individuals had to acquire a new understanding of what they needed to know, in order to perform the design. The group gradually realized this, collectively, through an adaptation of their work practices, using the "Aunt Sally" approach to design scenario generation and validation and co-constructing an external, organizational world of practice, as they proceeded. At a simplistic level, the types of knowledge valued could be categorized as relating to design goals, process, boundary or delivery. But a more detailed analysis of the ways in which the design group defined "required" knowledge at each of these stages reveals the model shown in Figure 3.

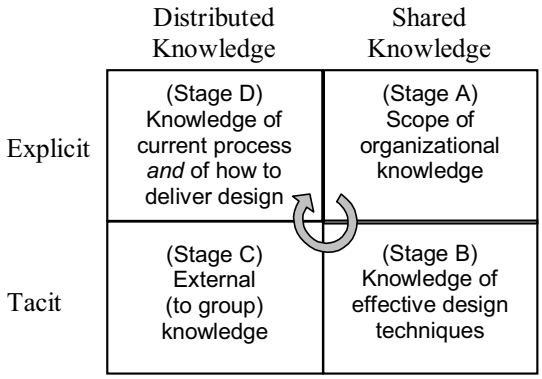

Figure 3: Modes of knowledge at different stages of design emergence

During *stage A*, the group focused on defining goals for the design - a task which they approached with the confident expectation that they could share existing, explicit knowledge possessed by group members. The most valued expertise was therefore that associated with a wide scope of organizational knowledge. During *stage B*, the group attempted to share tacit knowledge of organizational practice, by focusing on alternative design processes (specifically, the "Aunt Sally" method of scenario generation and adaptation). The most valued expertise was associated with effective design process techniques to achieve shared understanding. During *stage C*, the group recognized that there was tacit knowledge of the organization that they needed to access. The most valued expertise was therefore of processes external to the target system process. They invited external experts, to walk through work scenarios and they attempted to understand the tacit organizational by defining information flows and thus work-practices that "interfaced" with their own process. But the emphasis moved away from sharing this knowledge, to recording design information provided by others. In *stage D*, the focus moved back to explicit knowledge generation, as the group attempted to produce formal work procedures and IT system requirements as project deliverables. The most valued expertise was associated with knowledge of how the current process worked. But there was also a pragmatic recognition that knowledge of the target system of work-processes and information management was distributed across group members.

This was evident in the way that responsibility for delivering different areas of the design implementation was delegated to group "experts" in these areas. This allowed the group as a whole to consider the design complete, even though the specification work required to complete project deliverables remained substantial.

When an individual team member advocated a particular design solution, this was more or less successful, depending on the alignment of the knowledge produced to support their argument with the type of knowledge valued by the group at that point. So when the Project Engineering Manager wished to reopen the design inquiry to improve collective process definitions (during stage D), he was unsuccessful because the group focus was on abandoning the notion of shared knowledge in favor of individual responsibility for delivering specific areas of the design. The Bid Manager, on the other hand, was able to successfully propose a recidivist vision of the target system, because his vision aligned itself with the management of distributed knowledge necessary for design closure. Different design group members attempted to define areas of the design, at different times, by proposing specific design knowledge or representations for the group to use. But this attempt was only successful if the individual possessed expertise that was aligned with the current knowledge focus of the group. A change in the dominant representational genre heralded a radical shift in the type of knowledge perceived by the group as necessary for the design.

6. Conclusions

Knowledge resides in a shared, conceptual space, that is created through the co-construction of a socially-situated, organizational world [11, 15, 28]. By applying an analysis of how different types of knowledge interacted to produce collective learning and understanding, we have exposed the nature of such knowledge creation as socially-shared or distributed, rather than as individual or shared. The model in Figure 3 extends the framework of Cook and Brown [5], moving away from a notion of knowledge as possessed by an individual, to knowledge as embedded within a social community of practice. The two halves of the model echo the two views of KM developed in the IS literature. In the first two stages of the design project (the right-hand-side of the model in Figure 3), group members viewed the design process from the perspective of codifying knowledge about the design, through sharing first explicit and then tacit knowledge that they possessed about organizational practice. This reflects the knowledge externalization and formal IS focus of the KBS literature. With increasing design experience, the group focus shifted to managing distributed knowledge (the left-hand-side of the model in Figure 3). This reflects the human-activity and informal IS focus of the organizational KM literature.

These findings have significant implications for both research and practice. In most approaches to knowledge management, we assume that there is a shared perception of practice that defines how information is used. From a research perspective, we need to develop new ways of conceptualizing knowledge that is distributed among collaborative groups. In knowledge management practice, we need new methods for managing the surfacing and the coordination of distributed knowledge. The role of representational forms, or genres, in mobilizing a move from one mode of knowledge-manipulation to another may be significant in this endeavor. We have proposed a model by which this may be managed, which elaborates the coordination of knowledge-sharing emphasized by more comprehensive frameworks for knowledge management, such as that suggested by Holsapple and Joshi [8].

7. References

[1] Alavi, M. and Leidner, D., "Knowledge Management and Knowledge Management Systems". *MIS Quarterly*, 2001, **25**(1), pp. 107-136.

[2] Boland, R.J., Tenkasi, R., V, and Te'eni, D., "Designing Information Technology to Support Distributed Cognition". *Organization Science*, 1994, **5**(3), pp. 456-475.

[3] Brown, J.S. and Duguid, P., "Borderline issues: Social and material aspects of design". *Human-Computer Interaction*, 1994, **9**(1), pp. 3-36.

[4] Buckland, M.K., "Information as Thing". *Journal of American Soc. for Info. Science*, 1991, **42**(5), pp. 351-360.

[5] Cook, J. and Brown, J.S., "Bridging Epistemologies: The generative Dance Between Organizational Knowledge and Organizational Knowing". *Organization Science*, 1999, **10**(4), pp. 381-400.

[6] Dewey, J., *Human Nature and Conduct. An Introduction To Social Psychology*, 1922, Allen and Unwin, London.

[7] Hicks, R.C., "Knowledge base management systems - tools for creating verified intelligent systems". *Knowledge-Based Systems*, 2003, **16**(3), pp. 165-171.

[8] Holsapple, C.W. and Joshi, K.D., "An investigation of factors that influence the management of knowledge in organizations". *Journal of Strategic Information Systems*, 2000, **9**(2-3), pp. 235-261.

[9] Hutchins, E., "The Social Organization of Distributed Cognition", in L.B. Resnick, J.M. Levine, and S.D. Teasley, (eds.), *Perspectives on Socially Shared Cognition*, 1991, American Psych. Assoc., Washington DC.

[10] Kolb, D.A., *Experiential learning: Experience as the source of learning and development*, 1984, Prentice-Hall, Englewood Cliffs NJ.

[11] Lave, J. and Wenger, E., *Situated Learning: Legitimate Peripheral Participation*, 1991, Cambridge Univ. Press.

[12] Leibowitz, J., *Knowledge Management: Learning From Knowledge Engineering*, 2001, CRC Press, Florida, FL.
[13] Liebowitz, J., et al., "The role of knowledge-based systems in serving as the integrative mechanism across disciplines". *Computers and Industrial Engineering*, 1998, **34**(2), pp. 559 - 564.
[14] Nissen, M.E., Kamel, M., and Sengupta, K., "Integrated Analysis and Design Of Knowledge Systems and Processes". *Information Resources Management Journal*, 2000, **13**(1), pp. 24-43.
[15] Nonaka, I. and Konno, N., "The concept of Ba: building foundation for knowledge creation". *California Mgmt. Review*, 1998, **40**(3), pp. 40-54.
[16] Orlikowski, W.J. and Baroudi, J.J., "Studying Information Technology In Organizations: Research Approaches and Assumptions". *Info. Sys. Research*, 1991, **2**(1), pp. pp 1-28.
[17] Pettigrew, A.M., *The Awakening Giant*, 1985, Blackwell Publishers, Oxford, UK.
[18] Prusak, L., "Where did knowledge management come from?" *IBM Systems Journal*, 2001, **40**(4), pp. 1002-1007.
[19] Rosenbrock, H.H., "Engineers And The Work That People Do". *IEEE Control Systems*, 1981, **1**(3), pp. 4-8.
[20] Ruggles, R., "The state of the notion: knowledge management in practice". *California Mgmt. Review*, 1998, **40**(3), pp. 80-89.
[21] Schön, D.A., *The Reflective Practitioner*, 1983, Basic Books, New York NY.
[22] Schultze, U. and Leidner, D., "Studying Knowledge Management In Information Systems Research". *MIS Quarterly*, 2002, **26**(3), pp. 213-242.
[23] Schwandt, T., "Constructivist, Interpretivist Approaches to Human Inquiry", in N.K. Denzin and Y.S. Lincoln, (eds.), *The Landscape of Qualitative Research: Theories and Issues*, 1998, Sage Publications, Thousand Oaks, CA. pp. 221-259.
[24] Smircich, L. and Morgan, G., "Leadership: The management of meaning". *Journal of Applied Behavioural Science*, 1982, **18**(3), pp. 257-273.
[25] Star, S.L., "The Structure of Ill-Structured Solutions: Boundary Objects and Heterogeneous Distributed Problem Solving", in L. Gasser and M.N. Huhns, (eds.), *Distributed Artificial Intelligence, Vol. II.*, 1989, Morgan Kaufmann Publishers Inc., San Mateo CA. pp. pp. 37-54.
[26] Strauss, A.L. and Corbin, J., *Basics of Qualitative Research: Grounded Theory Procedures And Techniques.* 2nd ed., 1998, Sage Publications, Newbury Park CA.
[27] Suchman, L., *Plans And Situated Action*, 1987, Cambridge University Press, Cambridge MA.
[28] Suchman, L., "Constituting shared workspaces", in Y. Engestrom and D. Middleton, (eds.), *Cognition and Communication at Work*, 1998, Cambridge Univ. Press, New York. pp. 35-60.
[29] Weick, K.E., *Sensemaking In Organizations*, 1995, Sage Publications, Thousand Oaks CA.
[30] Yates, J. and Orlikowski, W.J., "Genres of Organizational Communication: A Structurational Approach to Studying Communication and Media". *Academy of Management Review*, 1992, **17**(2), pp. 299-326.