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FRAMING DESIGN: A SOCIAL PROCESS VIEW OF INFORMATION SYSTEM DEVELOPMENT

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Abstract

This paper discusses a social process model for design activity in organizational IS development projects, based upon the findings of an interpretive, participant observation study of information system design processes in a mid-sized UK telecommunications equipment manufacturing company. The form of the proposed model is a dual-cycle dialectic between opening up the design problem and narrowing down design solutions; it is also a dialectic between individual and group design activity in the context of participation in a social community of design practice. A social cognition perspective was used to analyze the activities of design in context; implications of the findings of the study for a process model of design activity are contrasted with managerial assumptions and practices imposed by the use of the traditional, decompositional model of design.

The paper has important implications for theory and practice. From a theoretical perspective, it is suggested that design team intersubjectivity regarding the goals and legitimacy of the *process* of design is a better measure of progress and design "completeness" than intersubjectivity regarding the form and requirements of the target information system. From a practical perspective, the adoption of a dual-cycle, convergence model of design might facilitate the management of detailed design activities between project milestones. The findings also have implications for the management of organizational "learning": if organizational problem-solving processes are seen as involving distributed and emergent knowledge, then an explicit goal of intersubjective understanding is not only inappropriate, it is not attainable.

Keywords: Socio-technical design, systems design, IS development approaches.

1. INTRODUCTION

An organizational information system may be viewed as an integrated social system of organizational actors, using information to perform purposeful activity, who may or may not use computer-based technology to facilitate their work and to provide information (Checkland 1981; Galliers 1987; Hirschheim, 1986; Land 1987). The conceptualization and design of information systems cannot be performed in isolation from those organizational processes in which the technical system is embedded: it is the design process which mediates between organizational objectives and information system function, between information and people, yet the processes of information system design are not well understood (Turner 1987). Optimal design, both in terms of organizational effectiveness and of user satisfaction, cannot be expected unless system developers possess the skills and knowledge necessary for good design. While the design of information technology is well-researched in experimental contexts, little research exists on the nature of those design processes which are situated in organizational contexts. This paper explores those processes, based upon an interpretive study of design in context.

2. A NEW PROCESS MODEL FOR MANAGING INFORMATION SYSTEM DESIGN

The traditional, rational model of design dominates most current organizational information system (IS) development practice (Friedman and Cornford 1989; Gasson and Holland 1996; Lewis 1994). This model, often referred to as the "waterfall model" (Boehm 1988) is based upon the conceptualization of IS development as a staged, linear, decompositional process. The model of *design* activity underlying this model is one of problem decomposition: a problem is decomposed into its component parts, which in turn are decomposed into components, and so on until a sufficient level of decomposition is reached for a solution to be assembled, by some technical-logical rationale, from the component parts. Five main problems may be observed when using this model to manage organizational IS development:

1. *The design problem:* While the traditional model provides a clear basis for managing the labor process in IS development, it artificially separates the conceptual and social processes of organizational IS development, which are referred to here as *design* processes. Design activity cannot be separated into a single stage of the system development lifecycle, as in the traditional model: requirements specification, design, and technical system implementation are intertwined (Bansler and Bødker 1993) and so require support and legitimacy at all stages of the system development life-cycle. Turner (1987) argues that "requirements and solutions migrate together towards convergence." Radical redesign of a technical system may occur even at the system implementation stage, when problems are encountered during interactive user testing; such redesign is often referred to euphemistically as "system maintenance" (Lientz and Swanson 1980).

2. *The process problem:* The traditional model is based upon the rational model of problem-solving (Newell and Simon 1972) —also referred to as the "information processing" model of human cognition (Mayer 1989). Prescriptions for design activity are based upon a decompositional, breadth-first exploration of the design problem, where *all* requirements for a solution are defined before problem decomposition is attempted. But empirical studies of individual design strategy show that design strategies are "opportunistic" in nature, adopting depth-first, iterative, recursive or 'inside-out' approaches (Ball and Ormerod 1995), based upon fitting known solutions to or reframing the problem, rather than decomposing it for rational analysis (Guindon 1990; Malhotra et al.1980).

3. *The framing problem:* The traditional model presupposes a design problem that is unitary in nature, exists independently of the designer's frame of reference, and is capable of analysis under conditions of "bounded rationality" (Simon 1973), where the designer bounds the problem until it is amenable for structured analysis. But design of organizational information systems centers upon the investigation of "wicked" problems (Rittel and Webber 1973), which are associated with interrelated, organizational systems of activity. Such problems cannot be "stated" or "solved" in the sense of definitive rules or requirements for a solution (Moran and Carroll 1996): they are socially-constructed and *subjective* (Galliers and Swan 1997; Schön 1983) and each problem is interrelated with—and thus cannot be defined separately from—multiple, other organizational problems (Rittel and Webber 1973).

4. *The teamwork problem:* The traditional model is based upon an individual, cognitive model of design, so approaches based upon this model cannot guide the critical activities required for group design, such as communication, shared learning and project coordination (Curtis, Krasner, and Iscoe 1988; Walz, Elam and Curtis 1993).

5. *The context problem:* The traditional model ignores the context of design as situated in a socially-constituted organizational culture. The *form* taken by a design involves both technical and social issues; for example, designers often debate the form of a technical artifact in terms of whether users should be prevented by its design from amateur repairs, or whether its design should reflect users' desires for conspicuous consumption (Callon 1991). Design is also political: an information system may change the nature of work for various groups within an organization (Wilkinson 1983). Design processes are viewed as irretrievably interrelated with context: design activity is "situated" in organizational contexts (Gasser 1986; Lave 1991; Lave and Wenger 1991; Suchman 1987).

Despite these problems, the traditional model has proved remarkably difficult to dislodge as the basis for how a "correct" IS development process is conceived: it has even successfully assimilated "alternative" development approaches that were originally conceived as a paradigmatic challenge, such as prototyping (Lewis 1994). Its main advantage lies in providing a definable

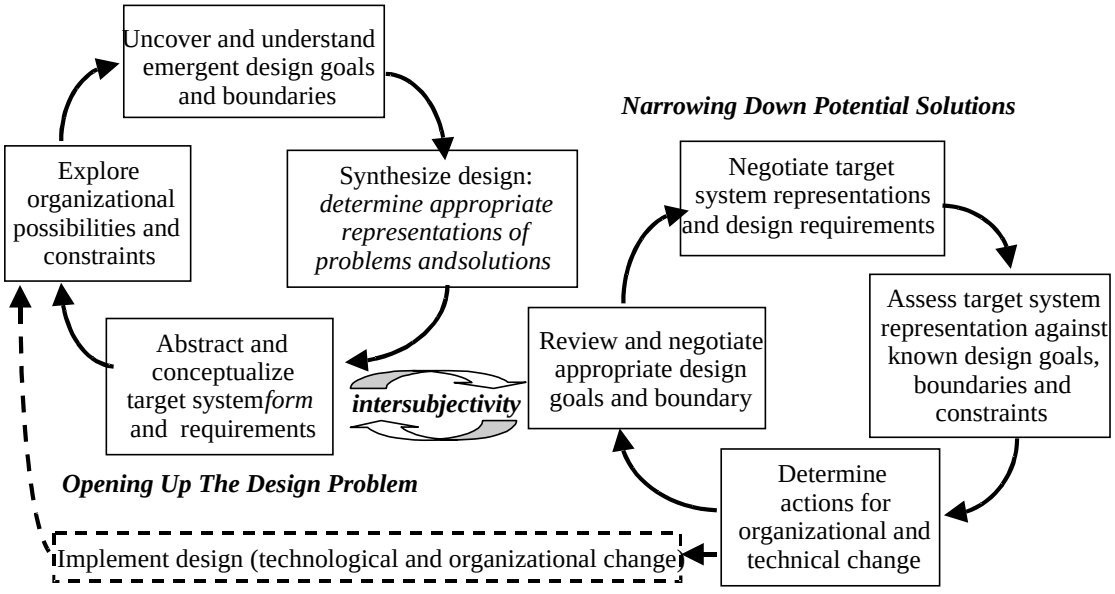

Figure 1. An Alternative Process Model for Organizational IS Design

structure to the system development process, giving at least the illusion of process control. Competing models, such as the evolutionary prototyping model (Eason 1982) or Boehm's (1988) spiral model have been advanced but, based as these are upon specific concerns, rather than generalizable processes, they fail to provide the basis for labor process management, which may explain why alternative development process models have had so little impact in practice (Gasson and Holland 1996).

An alternative process model, based upon the findings of a longitudinal, participant-observation study of a single, organizational information system design process, is presented in Figure 1. Unlike the spiral model or the evolutionary prototyping model, this model is based upon the detailed, empirically-observed activities of design in a group-based social context. The model incorporates the exploratory, learning nature of design as well as the need for closure and resolution; this is achieved through alternating cycles of:

1. *opening up the design problem:* investigating the design context and synthesizing design goals, target system requirements, and organizational possibilities—these are the *implicit* activities of design, which are largely omitted from labor process models such as the waterfall model;

2. *narrowing down potential solutions:* agreeing on appropriate sets of design goals and target system requirements and determining appropriate actions for organizational and technological change—these are those activities that are visible and legitimate from the perspective of "rational" models of design, but are here viewed from a social process perspective.

While the right-hand cycle is concerned with coherent group action for problem closure and decomposition, the left-hand cycle is concerned with individual and distributed activity, facilitating the exploration and complication of design possibilities. The attainment of sufficient intersubjectivity for design to proceed may require several iterations of the "opening up" loop: to attain problem synthesis to the extent that the implications of potential target system forms may be conceptualized. The group may then (and will periodically) engage in the more politically visible, "narrowing down" processes, to achieve intersubjective representations of the design and to test their individual conceptualizations against a group "model" of the design. The process will terminate when the majority of the design team feel that the distributed design model matches their individual design model

in sufficient detail *in those areas of the design which they understand*. The objective of the "narrowing down" loop is therefore viewed as satisficing, rather than as achieving complete intersubjectivity, in that it achieves a distributed model of the design. This model is advanced as a possible basis for a social process view of IS development. Use of this model to manage IS development might help to legitimize the conceptual and social activities of design, which have been observed to present problems in projects managed according to the traditional model (Curtis, Krasner, and Iscoe 1988).

3. THEORETICAL CONCEPTS: THE SOCIALLY-SITUATED NATURE OF DESIGN

Three theories of social behavior and social cognition informed this study: the concept of situated action, the idea of distributed cognition and the formation of communities of social practice. The underlying principle of situated action (Suchman 1987) is that human activity cannot be fully planned: people fulfil planned action by deriving loosely-defined objectives, the attainment of which they continually monitor, enabling them to make their actions contingent upon organizational circumstances. The nature of the emerging IS design "problem" thus becomes more complex and unbounded (and, indeed, unboundable) than that assumed in the bounded rationality model. Aspects of a solution are explored in conjunction with aspects of a problem understanding; the designer's understanding of both may change as a result of this process. This perspective, coupled with an understanding of organizational "problems" as dynamic and constituted of many, interrelated parts (Rittel and Webber 1973), leads to a perception of the critical processes of design as the exploration, representation, sharing, and *evolution* of partial, emergent design goals and the inductive assessment of when a satisficing solution has been reached. The core problem of design lies in agreeing an appropriate problem representation, to reflect a negotiated decisional structure among multiple stakeholders in the design (Lanzara 1983); *complication* of design goals, rather than complexity-reduction, is considered to be desirable (Boland, Tenkasi, and Te'eni 1994).

Recent theories of distributed or socially shared cognition (Hutchins 1990; Lave 1991; Norman 1991) have emerged to explain the social processes of group problem-solving and design. Individuals hold only partial mental models of a situation that, while inadequate as the basis for individual action, combine through coordinated group action to form a common frame of meaning which provides structure for group sense-making. Organizations may be viewed as "organized anarchies" in which people discover analysis- and design-goals from what they are doing: the processes of bargaining, learning, and adaptation (Clegg 1994). The focus is no longer on the individual as *decision-maker*, but on the individual as "*conversation-maker*" (Boland, Tenkasi, and Te'eni 1994), both through reflective action and through interaction with other stakeholders in the design.

The literature on socially-situated cognition deals with how individuals learn to participate within communities of practice and how their development is shaped by the activities in which they engage. "Legitimate peripheral participation" in a community of social practice arises from adoption of the sociocultural practices of the group (Lave and Wenger 1991): practical knowledge is acquired through peripheral participation in a group of experienced practitioners (as with apprenticeship); knowledge about how to develop an information system is not necessarily transferable to different situations (Brown and Duguid 1992; Lave and Wenger 1991). The contrast of a new paradigm of learning as the construction of social knowledge, with the paradigm of learning as knowledge transfer between individuals, is central to this area of literature and is also central to the understanding of IS design activity (Brown and Duguid 1992). In empirical studies, this concept is supported by the findings of Curtis, Krasner, and Iscoe (1988) and Walz, Elam, and Curtis (1993), who find that the communicative mechanisms which support shared social knowledge are more critical to the design process than use of a particular methodological approach. Social cognition theories build on the existing literature on the social construction of technology (e.g., Mackenzie and Wajcman 1985), to emphasize the need for a new epistemology for learning which prioritizes active perception over concepts and representations (Brown, Collins and Duguid 1989): the concept of "cognitive apprenticeship" is central to the shared, social construction of relevant "knowledge". Lave (1991) argues that the process of socially shared cognition should not be seen as ending in the internalization of knowledge by individuals, but as a process of becoming a member of a "community of sustained practice."

So from the traditional IS development emphasis of imposing structure upon a problem situation to facilitate convergence between a design problem-definition and potential solutions, we have reached a group design focus of coordinating and sharing partial design solutions and of participation in the "community of sustained practice," which is the design group. The nature of design activity in this context is explored in this paper through a participant observation study of situated design.

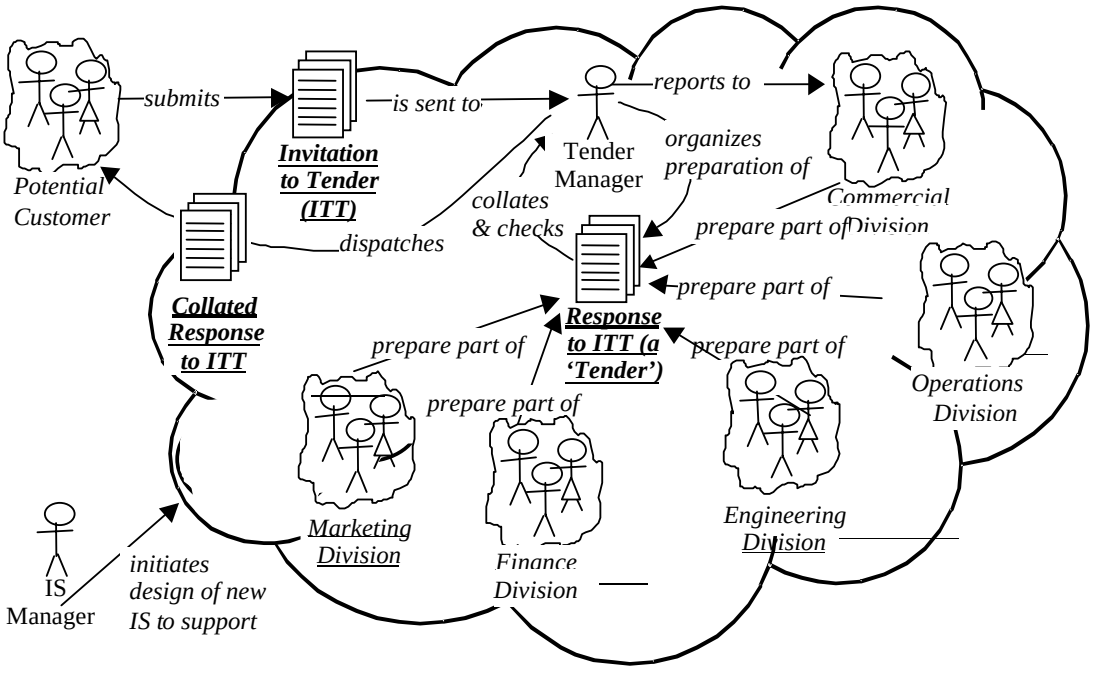

Figure 2. A Rich Picture of the IS Design Context

4. THE RESEARCH CONTEXT

This paper presents findings from a single, interpretive study of the information system design process engaged in by a small, multi-domain design team. An ethnographic field study of a small design-team engaged in information system design was performed over a period of 18 months, through participant observation. The study was carried out from November 1995 to April 1997, with Fujitsu Telecommunications (Europe) Ltd., a medium sized company specializing in the manufacture and installation of telecommunications equipment, mainly for UK and European clients. The purpose of the project was to design a new organizational information system, to support the processes of responding to customer invitations to tender for new business. A rich picture (Checkland 1981) of the IS design context is given in Figure 2.

The study commenced as the company was engaging in a new information system design project. The core design team involved representatives from all of the major corporate divisions, shown in Figure 2, in participative design: IS development, marketing, finance, product-engineering, operations-management, quality assurance, and customer support. None of the project design team had previous experience of design except for the Product Engineering manager, who had been involved in the design of electrical telephony systems and the IS manager, who had worked in IT design for many years. This was not seen as a problem because of the innovative nature of the intended project: organizational process design, as part of IS design, was a new departure for this company. Construction and testing of the technical support system required for this information system would be performed by IT development staff following delivery of the new IS design. The IS manager was attempting to do everything recommended by "strategic IS" literature: aligning IT with business strategy; planning business applications of IT to support work-processes rather than vice versa; and viewing information system design as a business, social, and organizational problem. The project was of particular interest for research because of the multiple organizational domains from which design team members were drawn, because of the explicit integration of business process investigation with technical system design, and because it gave the researcher the opportunity to observe the nature of an innovative design process, rather than observing standardized design procedures.

5. RESEARCH METHOD

Data collection was performed in three stages:

1. Initial interviews were held with project team members.

2. Project design meetings were observed over a period of 18 months: contemporary notes were taken, design representations recorded, documents collected, and meetings tape-recorded. Design team members were asked for comments at the end of each meeting.

   A soft systems analysis (Checkland 1981) was performed roughly half-way through the study, exploring the objectives and issues of individual team members and the group as a collective, to gain insight into perceptions of target information system objectives and design process objectives.

3. A feedback workshop was held at the end of the study, at which observations on the process of design were presented, giving design team members a chance to validate, comment and contribute to many of the perspectives covered here.

Research data were analyzed using multiple methods to provide rich insights into the design process and context and to provide a safeguard against limiting the scope of inquiry (Wolfe 1994). Following the suggestions of Mingers and Brocklesby (1996), Table 1 describes the use of multiple methods in this study in terms of the dimensions of the study (social, personal, and material) and the stages of the study (appreciation, analysis, exploration, and action to achieve intended outcome).

Activity-mapping, where activities were classified according to the categories derived by Olson et al. (1993), was used to understand the processes engaged in during design; hermeneutic analysis (Gadamer 1975), employing grounded theory coding and synthesis methods (Glaser and Strauss 1967), was used to analyze the intersubjective meanings and constructions of the design process; and an analysis of the internal, organizational actor-network (Latour 1987) was performed to understand contextual influences upon the design "trajectory." SSM modeling techniques (Checkland 1981) and cognitive mapping (Eden, Jones, and Sims 1983) were used to elicit and to analyze interview data to understand the ways in which designers understood the design (process and product) "problem." Transcripts and observation notes from four design meetings, selected at regular intervals during the design process, were analyzed using discourse analysis. Discourse analysis was based upon the decompositional approach used by Guindon (1990): this was used to understand the ways in which designers understood and constructed both the target object system and the intended process of design. Interpretation of the findings was grounded in elements of social-cognitive theory to investigate how IS design outputs, models, processes, and work-roles are constructed through the situated processes of design activity.

Table 1. A Description of the Use of Multiple Research Methods in This Study

	Appreciation of:	**Analysis of:**	**Exploration of:**	**Action to:**
Social	Activity-maps; hermeneutic analysis of design dialogues, SSM.	Design activities and designers' perceptions of their purpose.	Patterns in design activities and process.	Discern basis for generalizable social process model.
Personal	SSM methods and cognitive maps used to model individuals' 'system' definitions.	Team members' target system definitions and design process system definitions.	Individual vs. shared design and process-objective definitions.	Understand individual assessments of extent of intersubjectivity.
Material	Trajectory of design influences and mediating mechanisms.	Internal, actor-network of design initiative.	Political influences upon design	Understand constraints and drivers of design process.

6. FINDINGS FROM THE STUDY

6.1 Situated and Distributed Design Framing

It was found that design team members did not abstract system concepts and functions independently from the context of design, but based their abstractions on current practice or used examples and analogies from other business areas when their understanding of existing processes was insufficient to act as the basis for abstraction. There was a huge amount of contextual information that could not be captured by the design representation mechanism (a detailed process flowchart) and so was lost to the design team: this was explicitly recognized by team members and caused great frustration. While design synthesis occurred at multiple levels of decomposition simultaneously, it was captured at the single level prescribed for that "stage" of development by the traditional model. An analysis of average levels of decomposition during design meetings at different stages showed these to be remarkably similar, throughout the project, supporting Guindon's (1990) finding that design does not proceed by analyzing a problem at progressively lower levels of decomposition over time (which is axiomatic to the traditional model of design).

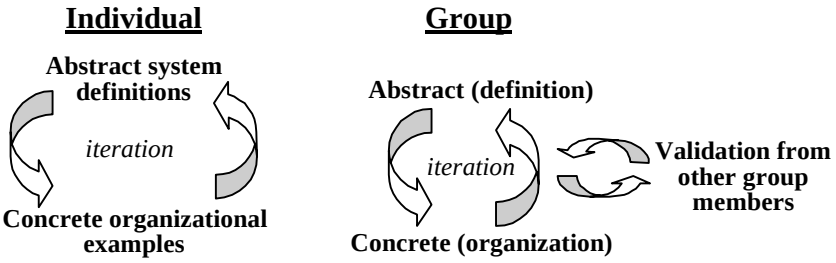

Figure 3. Design Framing at Individual and Group Levels of Analysis

The general pattern of design framing activity observed in design meetings is shown in Figure 3. It was observed that design team members continually cycled between understanding concrete examples of target system processes, or concrete examples of similar processes in other areas of the organization, and abstracting these exemplars to general process definitions. Members of the design team were unable to abstract "pure" business processes without visualizing them in the sociocultural context of the existing organization; they were then very easily able to criticize that context and to redefine business processes and information support. It proved difficult for other team members to understand abstract definition of a target system process without this being supplemented with concrete examples: in group design discussions, an abstract definition of a process by one team member would usually be validated by other team members in terms of exemplars which they would offer to the defining member; only once these had been accepted (or challenged) would the team be able to define the process in terms of an abstract definition.

Thus, individuals conceptualized problems and their solution together, by framing design "problems" in terms of the required organizational mechanisms and structures, then testing their mental model of this pairing against a real example or scenario. There was an explicit recognition of this in the team's acceptance that they would better understand the design "problem" once they had observed a "pilot" study of their prototype system design. Problem and solution were intertwined and inseparable: they were framed by a process that took place through a continual iteration between the concrete and the abstract until the individual was satisfied that they had a working model of the situation. This process proved trying to the IS manager, who viewed the need to articulate concrete design exemplars as a perversion of the intended, decompositional design process. He referred to the use of exemplars as "the specter of organization," saying:

> *I've had this constant battle with the team throughout the period, saying never mind the organization, think process, we'll sort out who does it later. [The marketing representative] has been the most difficult to persuade to park the organization at the side. His view has been, well this happens here and marketing does it; this happens here and operations does it.*

Many design goals appeared to be held implicitly, yet shared by several team members; these only surfaced when a goal held by a number of individuals was challenged by another team member. Designers reflected that using an "Aunt Sally" approach (where one designer produced an initial design model, then presented his vision to the others, who used it as a starting point for

their debate) was more effective than "design by committee." Through this process of "mental model prototyping," the team appeared to build sufficiently intersubjective models of the design for the design process to proceed, although team members did not always feel that they had understood the design individually. The team therefore worked in alternating cycles of problem exploration and problem closure, based upon the concretization-abstraction model shown in Figure 3: they constructed and explored *individual* conceptualizations of a target system component, then engaged in *intersubjective* closure of the design of that component through a process of context-specific negotiation and validation.

6.2 Building a Community of Sustained Social Practice

There were three discernable ways in which design representations were used. Initially, many different types of design representation were used, so the team's focus was on investigating diverse aspects of the target system. The role of external representations then changed as the IS manager attempted to achieve design closure. Representations were standardized and the critical task for team members became one of overcoming difficulties in learning to use the standard representational methods in a common way. Finally, the role of the design representation changed to being an external (to the team) communication mechanism to permit design implementation: the critical task of design now changed again to ensuring that these representations of the design were both correct and complete. It was observed that there would be frequent returns to "design anarchy" (as the IS manager viewed it), when individual team-members would arrive at meetings with non-standard representations with which to communicate their thinking about the target system. This anarchy continued throughout the process: the team appeared to cycle between design exploration, when multiple representations proliferated, and design closure, when the standard representation was adopted once more. As the design proceeded, the levels of trust built up between team members, coupled with experience that these differing representations would be absorbed into the common representation once they had served their purpose, led to less conflict over the use of alternate design representations: team members commented that they did not understand a particular representation of a designed component but that they trusted the team member responsible to have solved the common design problem in a sensible way.

The extent of intersubjectivity with respect to the target system was perceived as limited by design team members, as demonstrated by their widely-held belief toward the end of the design project that they still did not, *individually*, understand the basis for the design as a whole. This did not, however, affect their ability to function as a design team: the levels of trust built up between team members enabled individuals to delegate decisions on parts of the design which they did not understand to other team members. This aspect of behavior was much more noticeable at a late stage of design than at earlier stages, suggesting that an appreciable period of shared design is needed before a sufficiently high degree of trust is achieved for distributed design activity to take place.

In relating individual perceptions of the extent of design convergence with individual definitions of target system goals and of design processes, it became clear that achieving a common understanding of *objectives for the process of design* (for example, the extent to which the design team should or could manage IT-related organizational change) was more significant to designers' perceptions of design completeness and success than achieving a common understanding of *target system objectives* (for example, the extent to which the designed information system would formalize work procedures in the organization).

6.3 The Emergence of Design Goals and Boundaries

It was observed that the design process was more cyclical than any of those involved had expected: designed components were revisited multiple times as new, context-based information emerged and the target system design "model" was progressively understood. Late in the design process, the team reflected on how design goals had emerged from their debates about system functions and how difficult it was to capture this understanding at the time. A typical comment was:

> *Obviously, you get your objectives, as you understand them—you build up your picture of it—but you need a mechanism for updating it—capturing it and updating it. The amount of stuff that we've lost, to be honest,*

> *is absolutely appalling. A lot of really good work, good thoughts, ideas, and* ***problems*** *even. There are stacks and stacks of issues: the worst ones are the ones we can't think about!*

From an analysis of the content of design meetings, it is clear that not only target system requirements but also high-level design *goals* emerged continually, even at very late stages in the project. Clarification of the design at low levels of decomposition often instigated changes to high-level goals. A team member described this process as "working backward but recording forward." Individuals needed to start from an understanding of the goals and nature of a system component, for which they needed a comprehensive "bottom-up" investigation of that component, before they could engage in design decomposition of the component: the "top-down" design. Some of the rationale discussed in design meetings was retained by team members, but only if it fit into an individual's existing mental model of the process; otherwise it was lost or only realized to be significant by the individual at a much later stage. This factor led to many of the cycles in design: one team member would raise an issue which had apparently been resolved at a previous meeting and the design component would be reexamined and often radically changed. Discrimination between the significant and the insignificant (Turner 1987) was thus a critical activity of design: this was ill-supported by the decompositional design representation employed.

While the IS manager articulated the objectives of the new information system as supporting existing work-skills and initiative in a flexible manner (i.e., the system was conceptualized upon a Japanese model of the organization, which allows elasticity for continuous definition and redefinition of sub-tasks within a general framework [Egidi 1992]), the methodological design approach involved the recursive decomposition of work functions to define a set of prescriptive procedures for the system (based upon a Tayloristic model of the organization, in which the division of labor in the organization is managed prescriptively and hierarchically [Egidi 1992]). In the absence of suitable methods for a novel (to this organization) way of designing information systems, the IS manager stated that he had based his approach on the "structured" approach to design, as this was the only approach of which he had experience:

> *I did not have a model of the way to do it, but based my view on the traditional problem-solving model, of define a problem, analyze it, solve it.…never mind what the current process is, identify shortcomings and identify what functions you need in a process. Then, with a clear view of the shortcomings and a clear view of functions needed, you design a new process. We took a sort of systems design approach—define the bits you want and put them together in a logical sequence.*

The IS manager was increasingly aware of the mismatch between his perspective of the design "problem" and the emergent nature of the problem situation, but was unable to find a solution by changing the design approach, given the external pressures for closure which had been formed by the early statement of design objectives and benefits circulated to senior management. To change his perspective publicly would have meant public admission that he had misunderstood the nature of the design problem. Many, significant design achievements lay outside the very limited system boundary recognized by the initial design specification. As a consequence, the measurement of design progress and achievement was performed far too simplistically for this type of "wicked" design problem and so the team were unable to manage the expectations of influential stakeholders as it appeared to be achieving very little, when in fact it had achieved a great deal.

6.4 The Political Nature of Design Activity

The "management of meaning" (Smircich and Morgan 1982) played a large part in this design process and was largely driven by the IS manager, who was responsible for mobilizing the design team around a "common vision." In the same way that political parties are perceived as inadequate by the electorate if they air disagreements in public, the interests of political visibility required that the team "agree" upon a design and appear to be acting in common, even when disagreement and differences in perspective were required to explore and define design subsystems. This was due, in part, to the initial conception of the design initiative as providing "quick wins" through an analytical, decompositional design process, which presupposed that the design problem was reasonably unitary in nature and that it was well-understood. Neither of these turned out to be the case, as the IS manager ruefully reflected, later in the project.

The needs of external stakeholders dominated the design, leading to early over-reduction of the design problem. Team members' interests were aligned pragmatically behind the need to meet influential stakeholders' requirements and the design was "completed" even though individual team members felt that their understanding of the design was far from complete or adequate for closure. Team members did not feel able to investigate design issues which had been "frozen." Knowledge concerning current ways of doing things was more valuable for rapid closure than knowledge concerning more effective ways of doing things: this type of design knowledge dominated the design process, particularly at later stages. This caused discord within the team, as the explicit design process objective was to improve upon current ways of doing things. Toward the end of the project, design team members commented that the decompositional approach had led to too rapid closure. A typical comment was:

> *We should have spent a lot more meetings deciding what is the objective, what are we trying to achieve, how are we going to achieve it, rather than getting into the nitty-gritty of the design. It's quite clear, we should have spent far more time preparing for it, rather than writing the words.*

There was continual tension between the need to satisfy influential decision-makers and the desire to achieve an effective, coherent design. The needs of influential decision-makers were dominated by a desire for rapid closure of the design, while the needs of the design team were dominated by a desire to investigate and to understand the problem context. The strategy of problem reduction required for design closure conflicted with the strategy of problem complication required for design exploration. An understanding of this dialectic was implicit in the behavior of the design team, in the way in which an implicit system boundary coexisted with, but *did not replace*, the explicit system boundary. Published design specifications took on a contractual nature, particularly in respect of the initial system boundary definition, producing what Latour (1987) refers to as "immutable mobiles." As the design progressed and the complexity of the target business processes and their interrelatedness with other processes was understood, the initially-defined system boundary acted as a constraint upon the legitimacy of organizational investigation, even within the design team. Externally to the design team, the initial specification permitted unsympathetic managers to challenge the scope of the design investigation and to limit access to information. The team ended by working in a "gray area" between the legitimate and emergent system target boundaries—a twilight world of subterfuge and camouflage.

7. DISCUSSION OF FINDINGS

The above findings raised some critical issues for the way in which IS development is managed. The individual cycling between an understanding of concrete exemplars and an abstraction of the generalizable components of those exemplars, coupled with the need for a design group to achieve closure through validation by the use of organizational exemplars is a core component of design. Yet such activity is rejected by the most commonly espoused model of design activity, which is decompositional. The "specter of organization" is a key part of design; this finding supports Lave and Wenger's (1991) argument that the concept of abstraction is meaningless, as knowledge cannot exist outside of the sociocultural context to which it pertains.

The role played by divergent representations in opening up the design problem to exploration, as well as the tendency for representational convergence during cycles of closure, is significant: many development projects manage the labor process through enforcing representational conformance at the expense of managing the sociocultural processes of design exploration. The continual cycles between exploration and closure, coupled with the cycles of design caused by the inability of design team members to recognize the significance of design rationale until a sufficiently complex mental model of the target system has been constructed makes the design process difficult to manage when using a staged model of development.

It was observed in this case that the use of a decompositional development process model led to too early a freezing of design goals and boundaries, making the management of external stakeholders' expectations difficult. There was an over-concentration upon reporting achievements within the initial system boundary and an ignoring of significant achievements outside of this initial design boundary. The intended, autonomous work-support system was difficult to achieve using decompositional methods, given the pressures toward a prescriptive, rule-based definition of the design. The expectation of progress toward design closure engendered by adoption of a decompositional design process led to a continual tension between the need to satisfy influential decision-makers and the project team's desire to achieve an effective, coherent design.

The alternate model of design presented in Figure 1 is based upon the detailed observations and findings summarized in the previous section. An issue for future investigations of organizational information system design is the extent to which design goals and boundaries may be defined in advance of the process of design and whether use of a dual-cycle model might aid in managing progress toward specific design targets. It is envisaged that this model might be of use in aiding conceptualization of design activity between project milestones, rather than in managing the overall project life-cycle: the attractions for practitioners of a staged, measurable model of progress in managing the labor process are too great to be abandoned!

Another important issue is the distributed nature of design. Perceiving a design group's model of the target system as "stretched over" (Star 1989) the design group rather than shared between group members means that assumptions concerning measurement of design *progress* need to change. The explicit goal of decompositional IS development approaches is group intersubjectivity with respect to the target system (a "common vision") and a design is viewed as nearing completion when all members of the design group share this common vision. This goal needs to be recognized as unrealistic. To achieve *distributed vision* of the design, it needs to be recognized that achieving agreement on detailed IS development process objectives may be more critical to effective design than achieving agreement on target system objectives. Cycles of design to revisit "closed" specifications need to be seen as a natural consequence of distributed design, rather than as an indicator of ineptitude.

8. CONCLUSIONS

From a theoretical perspective, the socially-situated design processes observed in the study provide an insight into the implicit as well as the explicit activities of organizational information system design. This paper has illuminated the extent to which the goals and representations of a design are situated in and defined by their context and has demonstrated the interdependency of design problem definition and solution in organizational IS design. It has also demonstrated the inability of the decompositional model of design to act as the basis for detailed design activity and offers an alternative model for this purpose.

The dual-cycle model of design proposed in Figure 1 deals with the five problems identified with the decompositional model:

1. *The design problem* is resolved through basing the model upon the observed alternation and integration of the conceptual and social processes of design.

2. *The process problem* is resolved, as the cyclical nature of the model does not assume a hierarchical design problem structure, requiring a breadth-first, decompositional design approach. The conceptual separation of problem exploration from problem resolution, based upon differing approaches to design representation, is a central feature of this model.

3. *The framing problem* is resolved, as the iterative and exploratory nature of the "opening up" cycle presupposes an ill-defined design problem and permits investigation of its nature and context. Cycling between opening up and narrowing down the design problem permits the process to deal with changing conceptualizations of the system boundary and with emergent design goals and requirements.

4. *The teamwork problem* is resolved as the social processes of design are explicitly recognized in placing the attainment of intersubjectivity at the center of the model; social and political negotiation is also a core stage in the "narrowing down" cycle of the model.

5. *The context problem* is resolved by an explicit recognition of the needs of situated design in both cycles of the model. In each cycle, the process iterates between abstract and concrete conceptualizations of the design problem or its solution, permitting the physical and social context of the problem or a potential solution to be explored, design abstractions to be formulated and shared, then tested for fit against the concrete "realities" (the emerging constraints and requirements) of the design context.

A future research issue is to investigate this model further, with a view to deriving simple process models of design that are suitable for transfer into organizational IS design practice. The adoption of a dual-cycle, convergence model of design would

require innovative management approaches and the development of new tools and methods to support information system design in context. Given the research observations regarding the nature of design intersubjectivity, design progress between project milestones might be measured through an assessment of group "satisfaction" with the design rather than through an assessment of design "completeness."

It is suggested that the findings of this paper have important implications beyond the design of organizational information systems; they may fundamentally affect how we perceive knowledge management and organizational innovation. Current models of organizational "learning" view intersubjectivity (with respect to information or knowledge content) as an appropriate, if problematic, end. If organizational problem investigation processes are seen as involving distributed and emergent knowledge, then such intersubjectivity is not only inappropriate, it is not attainable. The focus of organizational learning thus shifts from *sharing* organizational knowledge to *accessing* distributed organizational knowledge, which is emergent and incomplete.

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