The Co-Design of Business and IT Systems

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Working Paper

Please cite this paper as:
Gasson, S. (2007) 'The Co-Design of Business and IT Systems', ***Working Paper***. Last updated 07/23/2007; retrieved <insert date of retrieval here> . Available from http://cci.drexel.edu/faculty/sgasson/papers/codesign.pdf

Introduction

The discussion in this paper is concerned with the collective processes of design engaged in by managers, IT professionals, and other stakeholders responsible for defining IT-related change in organizations. Enterprise systems definition groups, a.k.a. management taskforce, change management, or business process redesign/reengineering groups typically span organizational disciplines and structural boundaries and include people who work in a diverse set of business processes.

Conceptual Underpinnings

Organizational management has been conceived variously in terms of systems of problem-solving and decision-making (Simon 1977), systems of purposeful human-activity (Checkland 1981), systems of work-practice and organizational design (Greenbaum et al. 1991; Suchman 1998), systems of practitioners engaging in collective sensemaking (Weick 2001), systems of knowledge creation and transfer (Nonaka 1994), systems of situated learning and adaptation (Brown et al. 1991; Lave et al. 1991), and systems of distributed cognition (Hutchins 1995). Organizational problem-solving, information system design, knowledge management, and managerial decision-making may be viewed as involving essentially the same processes, analyzed at different levels of granularity and collectivity (aggregation). In practice, it is frequently assumed that Simon's (1976) model of decision-making, shown in Figure 1, may be scaled up to group processes, or processes that span organizational group boundaries, to provide a "universal" model of organizational decision-making. It is this model that underlies most methods for information systems analysis and design.

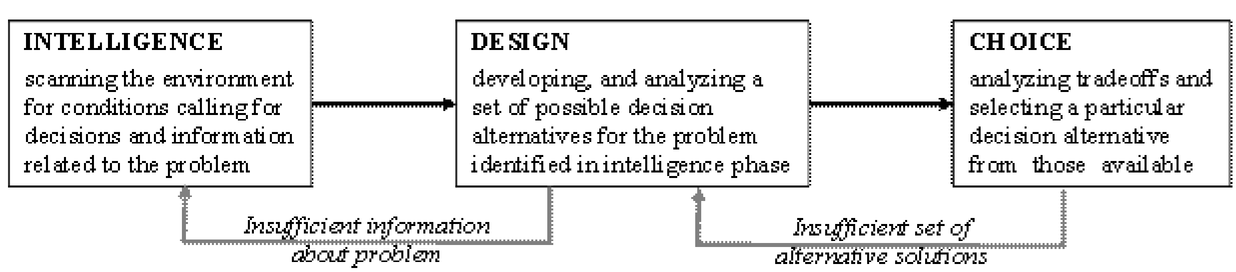

Figure 1. Simon's Model of Rational Decision-Making (adapted from Simon 1977)

This model, which was based on decision-making for “well-structured” problems[1] has been adapted as it was applied to increasingly ill-structured problems. Simon (1977) initially argued that ill-structured problems were inherent in the situation but too complex for humans to perceive. Their analysis involved bounding (reducing the number of problem-elements considered) and structured (determining the relationship between problem elements) before alternative solutions could be evaluated. In Simon’s later work, ill-structured problems were conceived of as emergent. “Because ambiguous goals and shifting problem formulations are typical characteristics of problems of design, the work of architects offers a good example of what is involved in solving ill-structured problems,” (Simon et al. 1987, pg. 24). Ill-structured problem solving was viewed as requiring iteration and the feedback loops shown in Figure 1 were added to the original, linear model. A core part of problem-solving is deriving a suitable representation for the problem, as the representation guides how the problem (and hence its solutions) will be framed . Simon ultimately argued that, although design itself was goal-driven, new goals could emerge from creating designs (Simon 1996, pg. 162).

This is a useful model of emergent design that has been adopted widely by technology-centered design research communities such as HCI and Artificial Intelligence. In these communities, the aim of design is to produce a technology artifact that has more or less useful properties (being user-friendly, or being capable of acting as a replacement for human decision-makers, respectively). However, it is insufficient to guide the basis of organizational information systems design as it does not deal well with multivocality. In the design of “artificial” systems, Simon focuses on the reduction and management of problem complexity and equivocality, describing techniques for problem representation that model “the architecture of complexity.” The emphasis is on the analyst as technology expert, mediating among complex views of organizational processes and goals to derive ***decomposable*** problem-structures (Simon 1996).

As Schein (1990) reminds us, this is only one of three roles of a consultant: acting as a domain expert, acting as a problem investigator, or acting as a process consultant. It is only in the last role that those involved in the problem situation are empowered to engage in solving their own problems. This is a huge difference. If the actors in the problem situation do not understand what problems they face, how can we “analyze” those problems? The traditional method used in information systems research has been to define requirements for IT-related change according to some “systematic” (i.e. reductionist) analysis of the situation. This often changes the problem-situation in unintended ways.

Systemic thinkers involved in discussions of processual and IT-related organizational change -- among them Churchman (1971), Ackoff (1974), Rittel (1972) and Checkland (1981) -- argue that we need to consider a problem-situation as a “system of systems.” This view stresses multivocality, emphasizing the privileging of ***multiple perspectives*** on both the goals of organizational work and its problems. As Rittel argues, organizational change systems present wicked problems, that are more interrelated and subjective than ill-structured problems. Wicked problems cannot be formulated definitely, or are formulated differently by various stakeholders, so it is not possible to define an “objective” set of criteria for their resolution, or even a boundary of change to structure the problem in Simon’s sense. They can only be resolved through a process of argumentation, where stakeholders and analysts progressively negotiate and define the problem through collective inquiry (Rittel 1972). Unfortunately, understanding the nature of such problems -- multivocal[2], interrelated, subjective, evolving, and only partially-comprehended by those involved in the problem-situation -- does not provide us with a methodology for their resolution[3]. To bring together a group of stakeholders in a way that allows them to become involved in defining a meaningful solution to their collective problems requires that the group develop a "shared language": a set of representations and descriptors that define an evolving understanding at the intersection of their various domains of practice. As Simon argues, the key lies in deriving suitable representations of the problem-situation (Simon 1996).

Peter Checkland presents us with a methodology for analyzing multiple systems of purposeful human activity: Soft Systems Methodology [SSM]. SSM provides a set of useful techniques for representing stakeholder perspectives of the problem situation as well as a philosophy of action that focuses on the facilitation of stakeholders in defining their own problems and organizational/IT change solutions. SSM also provides a useful research perspective, that compares real-world analysis of the problem-situation with ideal-world goal- and resolution-criteria setting (Checkland 1981). By using the representations suggested by SSM (supplemented with other systemic problem-representation techniques), we can produce useful boundary objects: artifacts or representations that are sufficiently elastic in their signification that various stakeholders can interpret them according to their needs, but sufficiently representative of knowledge at the intersection of relevant knowledge domains that they can mediate and transform shared knowledge at the boundary between various stakeholders' domains of practice (Carlile 2004a; Star 1989).

This discussion has highlighted three major challenges in managing the co-design of business and IT systems, that are not resolved by current research:

- The need to understand the process drivers that permit a design group to rapidly agree and constantly validate a common vision of their design.
- The need for effective "boundary objects": design representations that mediate and integrate knowledge that is distributed among multiple stakeholders.
- The need for a common language, that allows participants from a variety of organizational areas and backgrounds to understand and interpret the processes and concepts of design in the same way.

Research Method

This research investigates these three challenges, which are highly interrelated. For this analysis, I apply a framework based on understanding the meanings that stakeholders attribute to business processes and technology, in longitudinal studies of group information systems definition. This necessarily involves interpretive, ethnographic field studies of collaborative groups of organizational stakeholders involved in the co-design of business and IT system. The process that I term design (from an academic perspective) is often referred to in organizations as strategic information systems planning, early requirements definition, information systems definition and design, or business process redesign.

The processes of stakeholder groups engaged in the co-design of business and IT systems may be interpreted in terms of culturally-situated **technological frames**: the adoption of specific frames of reference with respect to technology, that derive from our membership of specific interest groups or communities of professional practice (Bijker 1987). An analysis of the dominant technological frames provides a situated understanding of shared sensemaking within a specific workgroup (Orlikowski et al. 1994). Shared frames represent a negotiated order that permits a group to operate cohesively, wasting less effort in resolving individual differences (Walsh et al. 1988). We can analyze technological frames through a qualitative analysis of individual utterances and group metaphors (Davidson 2002), or by comparing similarities and differences between individuals from various organizational groups (Orlikowski et al. 1994). It is also possible to employ elicitation techniques such as cognitive mapping (Eden 1998) or soft systems analysis (Checkland et al. 1998) to surface and analyze framing perspectives that reflect implicit knowledge about collective assumptions and practices (Gasson 2005). As framing-perspectives are situated within a local set of problem-definitions, meanings and culture, the dimensions selected to analyze framing perspectives must be tailored to the local, contextual focus. Orlikowski and Gash (1994) suggest that it is helpful to focus on the degree of congruence between technological frames, employing ***in vivo*** terminology to identify frame elements and frame congruence. There is no standard set of 'dimensions' for technological frame analysis, so I have developed an analytic framework based on the research concepts discussed earlier. I assess frame congruence in three sub-domains of practice, problem-space, solution-space, and process-definition, via an analysis of structure (possessing common categories) and content (with similar values in the common categories) (Orlikowski et al. 1994).

While the frame analysis provides an understanding of ***how*** collective understanding evolves, it does not explain ***why*** it evolves. Design involves the elicitation and sharing of organizational knowledge about the meaning of work-practices across multiple organizational and domain boundaries (Carlile 2002; Carlile 2004b). To examine process mechanisms, I investigate knowledge mediation between individual stakeholders in the problem situation by analyzing the use and evolution of **boundary objects**(Star 1989). Theories of distributed cognition posit that there is a distribution of cognitive labor across a social space encompassing humans and the artifacts and interaction-processes that allow them to coordinate work across diverse knowledge-domains (Hutchins 1995b). From a distributed cognition perspective, "the representations used by complex cognitive systems are in the external environment and available for inspection" (Flor et al. 1991, p. 39). For example, design engineers working on different parts of a shared information system or product design employ prototypes to understand dependencies and interactions between their designed components (Carlile 2002; Henderson 1999). Boundary objects such as design models, prototypes, or standardized work-practices provide a shared syntax or language for people to share knowledge, while allowing individuals to identify differences between their perspectives (Carlile 2002; Star 1989). By categorizing a collaborative design group's use of boundary objects – and by analyzing the interactions in which they engage in transforming boundary objects such as design models or standardized rules and procedures, one can understand the process mechanisms by which shared knowledge is transformed in group interactions. This provides us with an improved understanding of how to manage such processes.

Initial Findings

It would appear that the co-design of business and IT systems is facilitated by shared cognitive artifacts (Henderson 1999; Hutchins 1995b; Norman 1991; Winograd et al. 1986), or boundary objects (Carlile 2004a; Star 1989), that serve different process mediation roles at three levels of group coordination, as shown in Figure 2.

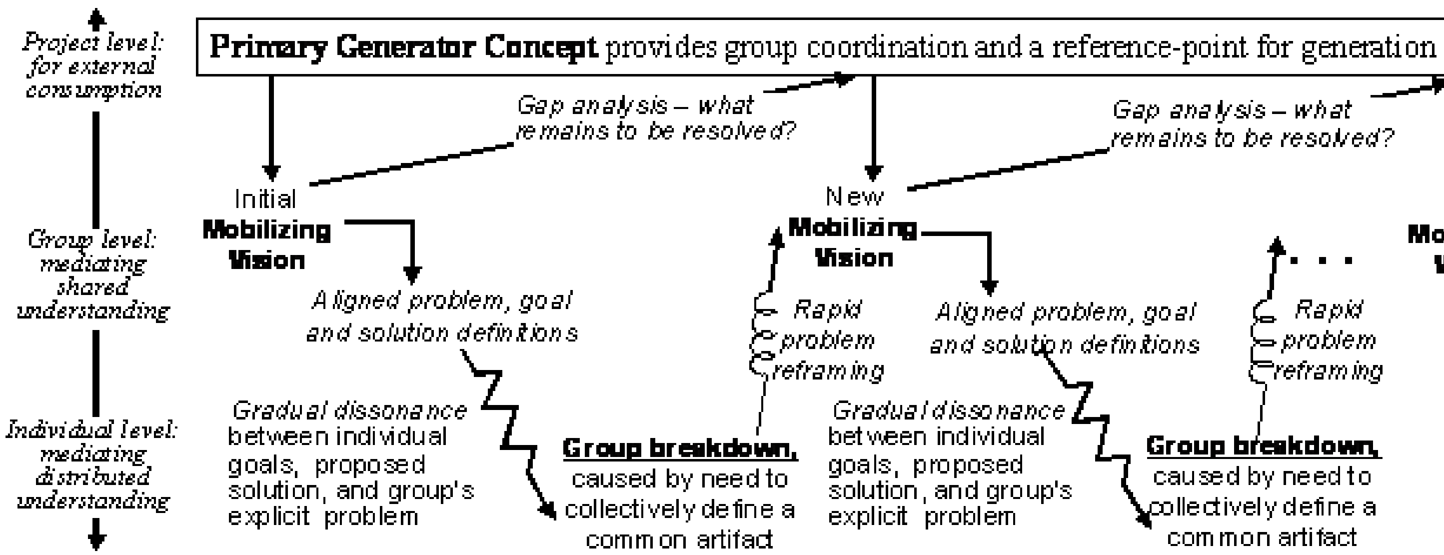

Figure 2. Process Drivers and Breakdowns in Boundary-Spanning Design

Project Level Coordination

At the consensus level, design appeared to be driven by a single, *primary generator concept*, that is defined very early in the collective process (Darke 1979). In Darke's study, architectural design was driven by a material exemplar that provided a conceptual metaphor for the design group, around which they could construct a shared vision. For example, designing around a ranch-house concept allowed architects to envisage the house in a consistent way across design-team members. In one of my studies, designing around a six-stage model of customer bid preparation and response allowed the group to coordinate their work while deferring a shared understanding of what was involved for each stage. The six-stage linear model that guided this design remained unchanged, ***even when it became apparent that the model no longer applied***. In another study, defining changes based on a "safe haven" model of privacy regulation coordinated the group effort, even after it was discovered that the group would have to adhere to a European Union privacy framework and incorporate Canadian privacy legislation standards in order to operate their systems globally. The term "safe haven" became synonymous with the group's understanding that they would adopt national frameworks against their will, providing a unifying concept that allowed them to coordinate distributed investigation of relevant frameworks.

Group Level Coordination

A *mobilizing vision* appears to provides coordination across internal, functional boundaries within the design group. The mobilizing vision is a conceptual technological frame that can be represented as a model or map type of object. This guides collaboration across individuals' intersecting design activities and viewpoints. It embodies an implied problem-structure that appears to align individual frames relating to the problem-space for a limited period of time. Each mobilizing vision builds on the previous one, providing a conceptual boundary-object that increasingly complicates the consensus problem-structure, as the group's design understanding evolves. Early mobilizing visions seem to take the form of models of the problem-structure that represent a consensus design solution, permitting collective (shared) design inquiry and analysis. For example, the group designing organizational and IT systems change to support data privacy regulations adopted a "legislation repository" vision that allowed them to debate the meanings of what information and knowledge needed to be acquired by various team "experts." This was replaced by a series of other problem-structures as their understanding of the change problem became more complex. Later mobilizing visions take the form of maps of the problem-structure that represent a consensus, abstract structure of the design product or the design process, permitting the division of labor in further design inquiry and analysis. As the work of the data privacy group progressed, they first employed a global map, using different colors to represent the privacy legislation standards of various countries in which they operated. It was clear that these standards represented different things to different managers. To the Executive VP of e-Commerce, they represented a marketing opportunity. To the business client manager, they represented a differential pricing justification. To the software applications manager, they represented a need to adopt different data storage and auditing standards. As the knowledge represented by the global map became too complex, they adopted a different vision, of "privacy regions" with similar legislative requirements and client operations. Each shared vision permitted them to use a common language in defining the required process and systems changes, for the duration of its utility.

Individual Level Coordination

The current mobilizing vision is replaced as the result of an explicit mediation of conflict during disruptions to the alignment of individual group members' problem or solution related technological frames. Although there appears to be a group expectation that each mobilizing vision will provide a shared model that provides a sufficiently common abstraction of the problem-structure that it does not need to change, this is not the case. The group suffers a *collective breakdown* when they need to produce a concrete model of the design solution that will communicate shared design knowledge across external group boundaries. The catalyst for the breakdown is provided by the need to produce a representation of the design for external knowledge transfer. Individuals experience increasing levels of conflict with their implicit beliefs (cognitive frames) about the design problem structure and scope. As they articulate aspects of these problem-frames, conflict increases until a critical mass of dissonance is reached. Various group members suggest alternative mobilizing visions until one is provided that satisfies the points on which individuals are conflicted with the previous consensus vision. It may be possible to manage this mechanism productively, by introducing collective breakdowns. It was observed that the most frequent catalyst for such breakdowns was the need to produce a boundary object that mediated between the design group and influential decision-makers in the organization. For example, when the group designing data privacy changes needed to produce a change proposal for the CEO, a collective breakdown triggered the evolution of their mobilizing vision from a national-standards map to a global-regions standards map based on commonalities in important privacy legislation rules.

Process Closure

As explained briefly here, the design process appears to proceed through the generation of a mobilizing vision, which provides a shared structure for the perceived design-problem faced by the group and enables them to collaborate on a shared solution for the problem. After a period of time, the utility of the mobilizing vision in providing a shared basis for making sense of the design problem breaks down and it is replaced by a new mobilizing vision that incorporates core problem elements from the previous vision, but also “complicates” the understanding of the group by reflecting a more complex problem-structure. In this way, the succession of mobilizing visions reflect an increasingly sophisticated understanding of the problem-structures faced by the design group. Eventually, when the group feels that the problem-structure reflected in the mobilizing vision adequately reflects the organizational problem, it is also perceived as too complex to solve collectively. Various parts of the problem-structure are delegated to different group members, for them to design a solution to that sub-problem. This problem partitioning results in a system of coordinated sub-solutions, that need to be negotiated only at the places where elements of the problem-structure are interdependent. Problem partitioning is now possible because of the high degree of trust engendered by the group’s shared vision. The shared vision represents the intersection of understanding about the problem structure at an abstract level, as the problem ***in toto*** is too complex for any one person to understand.

Conclusions

The findings above present an integrated view of interactions between process drivers in the co-design of business and IT systems, the mediating role of various boundary objects, and the derivation of a common language for design across stakeholder domains of practice. Research studies are ongoing, to understand the operation of these mechanisms, and to determine how these mechanisms may be applied to manage the co-design of business and IT systems productively.

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NOTES

[1] Well-structured problems are those where the structure of the problem indicates the optimal solution. These may be contrasted with ill-structured problems, which are too complex or uncertain for the problem-structure to be clear.

[2] The term ‘multivocal’ is used here to distinguish the privileging of multiple perspectives. This term is viewed as distinct from ‘equivocal’, which is a term used by analysts to denote a need for clarification in reductionist analysis.

[3] The term ‘methodology’ is used to denote a combination of a guiding philosophy or framework, and a set of techniques of methods for the inquiry (***c.f.*** Checkland, 1981).
