Progress and Breakdowns in Early Requirements Definition For Boundary-Spanning Information Systems [1]

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Abstract

Early requirements definition is an increasingly complex process for systems that span organizational boundaries. Where there is no unequivocal rationale for change, multiple stakeholders from various knowledge domains must be involved in defining the scope of change and the high-level requirements for the supporting information system – in effect designing the system in terms of form and overall function. Stakeholders have only a partial understanding of the business process as a whole, and tend to provide very different definitions of what is the systems "problem" that they face. The IS analysis team must therefore deal with IS requirements as an emergent stream of information from which they learn, avoiding premature closure. This paper presents an exploratory study, that attempts to introduce breakdowns into the group requirements definition process, as a way to achieve emergent learning in early requirements definition for systems that span organizational boundaries.

Keywords: Early requirements definition, boundary-spanning IS design, emergence, cross-domain knowledge-sharing.

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Introduction

Early requirements definition is an increasingly complex process for systems that span organizational boundaries. Where there is no unequivocal rationale for change, multiple stakeholders from various knowledge domains must be involved in defining the scope of change and the high-level requirements for the supporting information system – in effect designing the system in terms of form and overall function. Stakeholders have only a partial understanding of the business process as a whole, and tend to provide very different definitions of what is the systems "problem" that they face (Markus et al., 2002). The IS analysis team must therefore explore and reconcile incommensurate stakeholder perspectives and objectives for change. This paper presents an exploratory study of early requirements analysis for boundary-spanning information systems. We explore the processes of group problem-definition and resolution, employing a systemic approach to the analysis of such "wicked problems" (Rittel, 1972). We explore mechanisms for enabling a requisite variety of perspectives in organizational problem-solving (Weick, 1987) and we examine the role of cognitive breakdowns in this process (Winograd and Flores, 1986).

Conceptual Background

Early Requirements Definition For Boundary Spanning Information Systems

It has been argued that complex systems to support boundary-spanning organizational processes are irreducible to the forms of data-processing model that are commonly used to explore early requirements for information systems. Such environments present major challenges in capturing and integrating knowledge from heterogeneous domains. As this is such a complex task, information systems to support boundary-spanning business processes should be conceived as emergent, with appropriate methods employed to support an "ecology of requirements," that link and permit the evolution of relevant problem and solution spaces within the organizational environment (Bergman et al., 2002). Several alternative approaches have been suggested to deal with this. A prototype-based approach, where the development of a joint artifact (a core information system) is facilitated and guided by IS professionals was suggested as a way of supporting emergent knowledge processes (Markus et al., 2002). An approach based on systems development agility, possibly treating the requirements specification as an emergent boundary-object to mediate between stakeholder knowledge-domains has been suggested as an alternative approach (Karsten et al., 2001). Early requirements definition is a core part of an emergent design process, when the information system is complex and spans organizational, functional, or knowledge-domain boundaries (Bergman et al., 2002). Spiral approaches and prototyping present a pragmatic way of dealing with design complexity but they provide little insight into how a collective understanding of the organizational design problem unfolds.

Early requirements analysis is the stage at which a *form* is determined for an IS design. The IT system is merely a supporting system to a wider information system that includes human beings engaged in purposeful action – the *system of human activity* (Checkland, 1981). If we take a systemic (as distinct from *system*-centered) view of IS design, an information system is designed by teams of information professionals acting in support of a variety of organizational stakeholder groups, mediating between their various interests and perspectives. The ideal role of the professional is that of process consultant rather than process expert (Schein, 1990). There is a distributed understanding, across multiple stakeholders from different knowledge-domains, of what needs the information system must meet and what scope of change it will encompass, to meet what objectives. This is a classic "wicked problem", where a set of interrelated problems are novel, subjective, only partially understood. We need to encourage a "symmetry of ignorance", where everyone involved in the change is perceived as equally lacking in the expertise relevant to such a novel problem situation. In contrast, IT system development represents a classic "tame" problem, for which the definition of change goals and the subsequent definition of a design rationale and approach are unproblematic and well-understood. Wicked problems require design approaches that are based on argumentation, emergent problem representation, and goal-negotiation across stakeholder groups (Rittel, 1972). We may use a systemic approach to explore wicked problems. Of particular interest are those systemic approaches that encompass the analysis of human-activity systems, as these also focus on the multiple objectives and rationales pertaining to diverse *sub*systems of purposeful human activity within the organization. Soft systems methodology (SSM) focuses on the production of a diverse and integrated set of conceptual models that represent an ideal-world situation in which improvements to a problem-situation have been made. An effective set of changes may be defined by comparing the real-world situation with the ideal-world conceptual models. This approach has been employed for many years in action research and in information system requirements analysis to reconcile diverse stakeholder perspectives. An additional benefit is that SSM actively supports stakeholder learning. This provides the basis for a more integrated and dynamic definition of high-level information system change requirements (Checkland, 1981). Traditionally, systems definition process focuses on problem reduction rather than exploration. We have a large amount of research evidence to indicate that methods are used selectively by IS professionals, who pick-and-mix the elements that fit with their prevailing mindset. This mindset delegitimizes problem inquiry and equivocality, emphasizing process control and coordination over effectiveness of the system design (Gasson, 1999). The majority of IS project management approaches consider exploratory problem inquiry to be indicative of "scope creep." A systems development project is considered very high risk if the form and high-level scope and functions of the IS solution cannot be specified definitively during the early stages of requirements analysis (Karsten et al., 2001). IS professionals represent an exceptionally homogeneous interest group, the members of which are trained in normative engineering processes. These are designed to produce rapid, controlled problem closure and to minimize equivocality. Weick raises the harmful effect of homogeneity in his discussion of collective requisite variety:

> *Where technical systems have more variety than a single individual can comprehend, one of the few ways humans can match this variety is by networks and teams of divergent individuals. A team of divergent individuals has more requisite variety than a team of homogenous individuals. … If people look for different things, when their observations are pooled they collectively see more than any one of them would see. (Weick, 1987, pp. 115-116).*

Although we may have effective techniques for the definition of early requirements in IS-related organizational change, we lack the means to ensure that the multiple change objectives and diverse rationales of various stakeholder constituencies are represented in an analysis process that is facilitated by a team of IS professionals. We need ways of producing a collective requisite variety of perspectives in the IS design team.

The Process of IS Design

In individual design processes, the form of the organizational IS required appears to result from the co-evolution of a mental "problem-spaces" (the individual's understanding of the set of possible elements that, taken together, form the problem to be resolve) and a mental "solution space" (the individual's set of candidate solution components, or patterns from prior experience that indicate how various parts of the problem might be solved). By constantly fitting an evolving understanding of a problem-space with an evolving understanding of a solution-space, the individual derives a working model of the problem-situation and how it should be changed *at the same time* (Dorst and Cross, 2001). When solution sub-components are not available from the individual's experience, or that of others (colleagues and contacts) upon whom the individual can call for aid in problem-resolution, the individual may reframe the problem to fit available solutions (Turner, 1987). The collective process may involve a co-evolution process, but its form is somewhat different than the individual process of design. Organizations are in a constant state of emergence and hence self-redefinition. Most organizations are "self-designing systems", in that they constantly adapt to changing circumstances through improvisation. Organizations that find themselves incapable of such improvisation are less competitive and hence subject to dramatic failure (Weick, 2004). Conflicts may arise because there are multiple versions of organizational "reality" contending for acceptance during improvisation. Information systems designers must therefore design for "thrownness." They are thrown into the middle of an ongoing process of organizational redefinition and emergence, where multiple views of reality compete in ways that have become familiar to the organizational managers and knowledge-workers upon whom change-analysts call, when defining the goals and detailed objectives of change. They are thrown into multiple existing and interacting systems of organizational improvisation and emergence (Winograd and Flores, 1986; Weick, 2004). When we speak of "requisite variety" in boundary-spanning design, it is of this variety of worldviews that we speak. We throw IS professionals, trained in reductionist IT system design methods into a situation where they must deal with a variety of organizational realities arising from different interest groups, each of which appears to have an equal claim to validity (Corbett, 1995). While they espouse a more improvisational theory of action, experienced professionals tend to privilege one stakeholder perspective over others, in order to reduce the problem-space to a manageable set of requirements for change (Gasson, 1999). When reciprocity dominates group learning, organizational change and design groups quickly develop sufficient coherence to support shared sensemaking (Boland and Tenkasi, 1995). But the ability to participate fully and on an equal basis in collective problem-solving or design is often determined by locally-defined perceptions of legitimate knowledge and expertise. What is valued in one context may not be deemed so in another. Our understanding of what constitutes *legitimate* practice and knowledge is largely formed by normative practice in local workgroups, through which we acquire our understanding of how to be competent in a particular profession (Lave and Wenger, 1991). Procedural work in engineering disciplines – including supposedly "creative" work such as design – tends to be constrained by normative thinking that results from the formalisms and conventions of group apprenticeship (Rosenbrock, 1981). This "investment in form" of procedural bureaucracies and existing structures of action outweighs considerations of flexibility and adaptiveness as new requirements emerge (Latour, 1987; Star, 1992). An individual who suggests reconsideration is treated as a dissident and excluded rather than involved centrally in the ongoing process of design. To counter this tendency, an effective design process for novel IS must focus on complication, rather than reduction of the problem-space and solution-space. We need to introduce the "symmetry of ignorance," that was discussed above, where no one stakeholder group or individual can assert a claim to relevant expertise (Rittel, 1972). Group members must be equally involved in defining both the collective problem-space and the collective solution-space to achieve the desired requisite variety of problem and solution definitions for effective IS design.

To this end, we may consider the role of *breakdowns* in a collective process of design. The centrality of breakdown in design is related to Heidegger's (1962) argument that objects and properties are not inherent in the world, but are simply "ready-to-hand": unreflectively incorporated into automatic routines. A disconnect in the seamlessness of their use produces a breakdown. The artifact becomes visible in use, or "present-at-hand": the subject of reflection and redefinition (Winograd and Flores, 1986). Automaticity in use results from the individual's experience of incorporating similar artifacts into one's work-routines. When I am hammering in a nail I do not concern myself with the process of hammering, I just do it. When the hammer is too heavy for the nail or if the hammer breaks, I am forced to reflect not only on how the hammer is constructed, but also on the process of hammering-in-context – how a hammer is used, in what circumstances certain hammer designs work, and why certain hammer designs fit with different types of hammering-process. As a result, I understand both hammer design and the process of hammering much more deeply, permitting me to select the right hammer for the job. So breakdowns may be productive in design. They force a disconnect in the assumptional flow, leading to a reexamination of design rationale and objectives. Extending the concept to group processes, it is possible that *collective breakdowns* hold the key to achieving requisite variety in boundary-spanning design. An early homogenization of problem perspectives can be harmful, resulting in premature specification – locking in the form and functions of the solution before the requirements for change have been understood. But premature specification occurs even when the method in use *should* sensitize group members to the multiple perspectives required for effective problem mediation. Groups of IS professionals trained in methods for rapid problem closure are highly homogeneous in their culture and focus. This paper explores mechanisms for disrupting that culture and focus productively, in early requirements analysis.

Research Method

The research design results from prior studies that found that group IS design cycles between a focus on problem inquiry and a focus on problem closure These studies concluded that the shift between an emphasis on problem inquiry and an emphasis on problem closure was brought about because of a collective breakdown that resulted from external stimuli or a redefinition of the project deliverable focus (Gasson, 1999, 2006). **The study reported here was therefore designed to explore whether a redefinition of the project deliverable focus could bring about a productive form of collective breakdown – one that increased individual involvement in group decision-making to increase the requisite variety of perspectives considered.** This paper presents an action research study (Baskerville and Wood-Harper, 1996). A College of Nursing was seeking ways to respond to this integration of technology, by integrating portable technology into their education and development programs. Increasingly, PDAs are used by nursing professionals in their daily work, to provide instant access to patient records, healthcare databases, and information about specific illnesses, treatments, and symptoms. The College wished to educate technology-illiterate students and faculty in the potential uses of portable technologies, by integrating PDA technologies into their educational curricula. This raised issues of the role that PDAs could play in the collection and delivery of confidential personal (patient), professional, instructional, and research information that had previously been delivered via highly-centralized systems of information technology.

This study focused on the analysis of four groups of graduate students taking a course in early requirements analysis as part of a Doctoral or Masters Information Systems program. They were assigned to perform an early requirements analysis, investigating and suggesting solutions to this "wicked problem" (Rittel, 1972). All groups analyzed the same problem-situation, with access to the same groups of problem stakeholders: faculty, nursing students, department administrators, technology support, information management, and program development administrators. All groups were required to use Checkland's (1981) Soft Systems Methodology (SSM), supplemented with Wilson's(2001) adaptation of SSM to integrate primary task perspectives of organizational goals. Although SSM encourages the direct involvement of stakeholders in analysis, this was not feasible within a 10-week course schedule, with a focus on learning a completely novel (to the students) approach to early requirements analysis. Nor did stakeholders have the time or interest to be involved as participants. The selection of SSM as the core analysis method, coupled with assessment evaluation criteria that rewarded iterative stakeholder involvement, ensured that students adopted the mediation role of process consultant rather than process expert (Schein, 1990). All of the student participants had some professional IS development experience, ranging from 2 years to 18 years, with an average experience of 4 years. Their approach to group problem-solving could therefore be considered typical of the profession. There were two groups of four students and two groups of two students who provided sufficiently detailed data for the research study (see Table 1). While dyads are known to be more cohesive in their collaboration than larger groups, requiring less time and effort spent in communication and activity alignment, small groups that have an even number of members may be considered equivalent, as they do not suffer from the fragmentation common to odd-numbered groups where one person (or a minority) is disadvantaged by an alliance of the majority (Hare, 1981). The most significant effect on group cohesion may not be group size, but demographic fault-lines, especially sex, age, race, or occupational role. Groups that are evenly balanced between subgroups are likely to be similar in outcome, regardless of group size (Lau and Murnighan, 2005). In dynamic, high-uncertainty conditions, groups must develop interdependence mechanisms, coordinating activities, developing trust, and coming to rely on each other. Groups that perform well may be expected to both experience and report higher levels of cohesiveness (Myers and McPhee, 2006). This study examined whether this process of social inclusion can be managed to some extent by introducing discontinuities in the work-context to force breakdowns in group understanding of how to proceed. The instructional method was designed to provide disruptions to the normative thinking that dominates engineering disciplines (Rosenbrock, 1981). While all of the course participants were familiar with the relatively well-structured formalisms of systems analysis methods (and had experience of applying these in their organizational work), they were all equally unfamiliar with a systemic approach to early requirements analysis. They therefore shared a "symmetry of ignorance" (Rittel, 1972) regarding the analysis approach. This ensured that each group member had the potential to be equally involved in analyzing the IS "problem" and defining requirements for its solution. The course was designed around a term project with two equally-spaced deliverables.

- The first project deliverable focused on systemic *problem inquiry*. It required each group to analyze competing human-activity system definitions and boundaries for change (Checkland, 1981). Groups were to produce a stakeholder analysis that summarized differences in perspective and to reconcile these into an integrated business process model that identified the "primary tasks" of the organization (Wilson, 2001). The objective was to summarize the relationship between competing change priorities, explore a consensus scope for change, and to identify alternative boundaries and subsystems of the organization that could provide the focus of change. The criteria for success were related to the diversity of perspectives, stakeholder-representativeness, and depth of analysis, applying SSM analysis techniques to explore interrelated problems that were separated out into distinct process goals and their required set of work-activities, suggested by various stakeholder groups.

- The second deliverable focused on *problem closure*. Each group was required to provide a coherent *solution* to a prioritized subset of the human-activity systems modeled in the first half of the course. The group assignment was to investigate and model a stakeholder *consensus* on the reorganization of work (business processes, actors, and management roles), changes to the technical support systems, changes to reward systems and incentives, and a plan to implement the recommended changes. The explicit criteria for success were related to the depth and scope of the group's integration of various stakeholder change perspectives, to produce a coherent set of requirements for both business process and IT system change. While the emphasis was on problem-closure, this was managed by providing explicit criteria that rewarded an integrationist rather than a reductionist solution.

Table 1 summarizes the data collection and analysis approach employed for this study. The primary purpose of student papers and the instructor journal was to support a constructivist, reflective-learning approach to instruction (Schön, 1983), but these also provided an in-depth, week-by-week reflection of individual interpretations of IS-related problems and solutions, and reported on how each individual saw their contribution to the group analysis. Combined with individual student interviews and surveys, the research design provided multiple sources of data, to triangulate and validate findings. Group process and individual involvement was assessed by means of a short questionnaire administered at three points in the course. Immediately following course completion, a critical incident analysis (Flanagan, 1957) was employed, with data gathered by means of individual interviews with group members. The analysis explored the group drivers and rationale at points at which the group changed or resolved to retain its definition of the problem or the solution space, or the group process used for early requirements investigation and definition. Critical incidents were self-reported (the most commonly-employed approach, according to Butterfield et al., 2005). Interviews were conducted by a graduate student who had been trained in the critical incident technique, to remove instructor bias of student reports. Unsurprisingly, given the structured nature of an academic course, each group member reported on eleven sets of activity that were associated with the ten weeks of the course plus the final report and presentation to stakeholders. A detailed content analysis of interviews revealed that a coherent interpretation of changes in group direction emerged across all subjects in each group at specific points. Applying this definition of "critical incident" provided seven critical incidents for each group. These were identified with codes taken from participant accounts to avoid the imposition of an artificial categorization scheme, then categorized across groups. The episodes were not contemporaneous across groups, in that similar changes might occur one week earlier for one group compared with another, but they did appear to reflect similar types of changes across all groups. Several credibility checks were performed (Butterfield et al., 2005). Critical incidents for each group were categorized by two coders working independently, and then triangulated against the instructor observation journal. A content analysis of weekly reflection papers was triangulated against the interview findings and observations from the instructor journal, to provide a detailed and credible account of group processes.

Table 1. Data collection and analysis

Source	***Frequency***	***Analysis***
Interviews to elicit critical incidents	Post-hoc	Critical incident categorization, validated across members of same group, followed by content analysis to determine congruence between accounts of how and why group roles or process changed, in defining the IS problem or solution.
Instructor journal to record student & group process	Weekly	Content analysis of observations from facilitated meetings with student groups and from individual student interactions. Assessment of who did what and why. Also noted how much student appeared to feel that their perspective was appreciated by group as a whole.
Student reflection papers	Weekly	Content analysis, to categorize student perceptions of group analysis goals and behavior, and the degree to which the student felt involved in decision-making.
Participant questionnaires	Start of course	Self-assessment of prior knowledge and experience of systems requirements analysis, systemic or soft systems analysis. Findings triangulated with instructor journal.
Participant questionnaires	Mid-point & end	Self-assessment of how much individual feels that their perspective is included in group decision-making. Report of who did what, for each course deliverable.
Stakeholder project evaluation	End of course	Two "client" stakeholders provided detailed feedback (recorded by instructor), to student groups following presentation of both problem (midterm) and solution (end of term) analysis. Stakeholders also completed a feedback sheet, which scored each element.

Findings – Group Diversity and Critical Incidents In Group Process

These findings are organized as a time-series of critical incidents for each group, to provide a view of each group's emergent design processes over time. However, as explained above, findings were compiled from multiple data sources and analyses, to provide triangulation. Where possible, the critical incident names use the *in vivo* codes that were common to all group members. The process and role categories are derived from the terminology employed by those performing these processes and roles.

Critical Incidents For Group 1

The least experienced group consisted of four students in their mid-twenties who had some industry background in systems development but at a junior level. These students were remarkably similar in their depiction of critical incidents during the course and presented a very coherent view of analyzing a wicked problem as a group. In the first half of the course, their defined critical incidents appeared to be related to understanding how to conduct the investigation; in the second half of the course they were strongly focused on understanding consensus and validating their plan for change.

Critical Incident 1: Understanding course requirements
Process: The group held a meeting to discuss what was required for the course and to devise a plan of action.
Group roles: The group allocated a division of labor around interviewing various stakeholders. After each interview, the group convened to understand requirements in common and to identify the next stakeholder for interview.

Critical Incident 2: Planning questions for further inquiry
Process: The group held a meeting 2 weeks later, to discuss what questions needed to be asked, to elicit requirements for change, following the initial stakeholder interviews.
Group roles: Each group member had sub-interests within the broad problem domain. For example, one group member knew some of the Nursing students and offered to liaise with them, another interviewed a stakeholder who had presented a very technology focus to obtain more information about processes, while two group members collaborated in producing analytical models as the group assembled information about the situation.

Critical Incident 3: Understanding midterm deliverables
Process: The next stage was "to determine what work was required and how to produce this by the deadline."
Group roles: Group members derived a joint vision of what was to be done, then chose which processes they would like to work on. The processes were based on the actors involved. The group chose the actors and the tasks associated with the role, e.g. one member would choose teacher tasks, while someone else chose students.

Critical Incident 4: *Evaluating midterm report*
Process: Once the initial report had been produced, the group realized that they had insufficient information to address the scope and range of perspectives that were required. They collaborated on "evaluating" their midterm report, validating their perspectives with various stakeholders.
Group roles: The group identified further stakeholders based on social network contacts they had individually made during the initial investigation. At this point deadlines were looming and the group satisficed their analysis: "If some one said something in a definitive manner other chose to follow this opinion."

Critical Incident 5: Determining focus for second part of course
Process: The group chose their focus for the reduced-scope change analysis based on those human-activity systems that everyone understood well and the competency of various group members to analyze different processes.
Group roles: The group took a majority vote on which areas to pursue, based on their understanding of the impact that could be achieved. One group member felt that their idea was dismissed as it would not have sufficient impact for a short-term analysis. Some members naturally took the lead on certain issues that they felt comfortable with.

Critical Incident 6: Planning group work and validation processes for final report
Process: The group planned their work again around a division of labor, but this time they incorporated stakeholder validation into their processes. Analysis models and change-elements were circulated by email and amended/debated by each person in detail.
Group roles: Change-requirements analysis was now divided by stakeholder groups: the group-member responsible for a particular stakeholder analyzed their requirements and liaised with a stakeholder-group representative to validate relevant actor roles, processes, and criteria for acceptance.

Critical Incident 7: Delivery of final report
Process: Group report sections were annotated and commented on by email, with very few face-to-face meetings.
Group roles: Each member was allocated a section of the report and produced an initial version of that section. All members read and annotated each section; changes were made by the person responsible for that section.

Critical Incidents For Group 2

The most experienced group consisted of four students in their early to mid-thirties who had a great deal of industry background in systems development and were mostly junior managers. These students were remarkably diverse in their analysis of the situation, but their depiction of critical incidents during the course was very similar. In the first half of the course, their defined critical incidents appeared to be related to understanding how to apply the SSM method; in the second half they were focused on dealing with perceived changes in the goals of their analysis.

Critical Incident 1: Analyzing Initial Stakeholder Interview
Process: With one exception, group members worked full-time, so project activities were planned by email and around who was available at specific times. Group members each submitted questions to whoever was available to conduct an interview. The group compiled a joint set of "standard" questions for stakeholder interviews. One group member interviewed one of the two initial project contacts. They produced an initial rich picture of the situation. The two software engineers in the group, who worked near to each other, conducted a second stakeholder interview. The group each produced sections of an initial problem-analysis report. The two software engineers produced a functional "software requirements" section, while another student who produced a rich picture (an SSM model).
Group roles: The initial interviews and models were produced by anyone who was available at the time. There was no-one allocated to edit or merge sections, so the initial report reflected a disparate set of views. One of the software

engineers now took the lead. He developed the rich picture of the situation from the initial rich picture produced by another group member, adding new information as this emerged from interviews. The least engineering oriented group member produced an initial process analysis.

Critical Incident 2: Determining The Analysis Scope

Process: The group decided to limit their scope of analysis to PDA use in educational development and delivery. This was largely led by the interests of the first stakeholders to be interviewed, but also provided a way to reduce the complexity of an inquiry process where group members were distributed across different locations and limited in their availability. New problems emerged from the second set of interviews, which were developed through a rich picture analysis produced by one of the two software engineers.

Group roles: Group members were confused about the soft systems method. So they divided the modeling by problem-analysis, so that each person could experiment with the method to understand how to analyze the situation.

Critical Incident 3: Analyzing The Problem Situation

Process: Group members each took a subset of the problem domain and investigated this separately, interacting by email with the two main contacts in the College of Nursing and contacting other relevant stakeholders by email or in person to address specific issues.

Group roles: The more experienced software engineer now took charge of defining the overall problem areas and identifying “subsystems,” that were defined around the use of technology for various purposes. The group were still confused about how to apply such an unstructured (i.e. inquiry-based) analysis method to their subsystems. So they scheduled a meeting with the instructor, in which they produced an initial process model that integrated the four sub-domains that they had defined for the problem-situation: (i) student technology use, (ii) educational outcomes assessment, (iii) instructors’ familiarity & use of technology, and (iv) technology support for instructors & students.

Critical Incident 4: Producing The Midterm Report

Process: Group members each took a “subsystem” and analyzed these independently. Their analyses were then written up in separate subsections of the midterm report and compiled together. The final report was edited and merged by one group member.

Group roles: Each group member stayed with their selected domain of analysis to write subsections of the report. The two software engineers directed the overall content. The least engineering-oriented group member was responsible for merging and consistency-checking, but took a lesser role in the problem analysis.

Critical Incident 5: Selecting The Implementation Focus

Process: Two subsystems were selected that would be similar in their objectives (to permit student feedback about (i) educational objectives, and (ii) technology use and value to be collated).

Group roles: One of the software engineers guided the selection of domains to be analyzed for the change management plan, based on his own interest in modeling an IT system to collate student feedback. Subsets of analysis were allocated to individual group members, that were defined to be relatively independent.

Critical Incident 6: The “Transformations Fiasco”

Process: Following a presentation in class, it became apparent that the software engineering focus of the group had limited the scope of their inquiry, so that they were modeling a very IT-oriented (instrumental) view of change-management. The group met with the instructor to understand the focus of a human-activity system analysis. In particular, they were confused about a concept unique to some approaches to SSM, of a process “transformation.” This analysis explores the role and purpose of a subset of human-activity, defining the processes that are performed by reference to how outputs are transformed from inputs to the processes. While individual group members suffered a great deal of existential angst as they coped with adjusting their normative worldview of “systems analysis.” Some coped with this better than others. The two software engineers attempted to keep their existing focus, adjusting the scope of analysis to integrate IT processing more tightly. They protested at the need to “change what they were doing.” The two less engineering-oriented analysts continually attempted to produce new models of human-activity systems, only to have these rejected or revised by the two software engineers.

Group roles: Following group discussion, each group member selected a section of the final report to work on. The two software engineers worked collaboratively. The two less engineering-oriented analysts worked separately on different subsets of the problem domain.

Critical Incident 7: Producing The Final Report

Process: Individuals corresponded with stakeholders via email to obtain information about sub-processes that they were analyzing. The group then merged their analyses and divided the report write-up according to expediency of completion. Many of the softer aspects of the analysis were lost at this stage.

Group roles: Following a face-to-face discussion, each group member selected sections of the report to complete and reconcile. The final report editing and merging was performed by the two software engineers.

Critical Incidents For Group 3

One of the two dyads worked together very cohesively. This group consisted of two students with extensive systems analysis and management experience, who were researching organizational issues as part of their doctoral program of study. However, these individuals differed from the members of other groups in that they were explicitly seeking a less technology-oriented approach to systems change, to fit this with organizational change.

Critical Incident 1: Initiating The Inquiry
Process: As they appeared to have an organization-oriented emphasis, these two students immediately focused on obtaining as wide a view as possible of the problem situation. Their explicit emphasis was on resisting the urge to over-simplify the situation, so they each produced a number of initial rich picture models, using these as boundary objects to explore their emerging understanding with stakeholders and with each other.
Group roles: The two group members identified groups of relevant stakeholders and divided interviews between them, meeting frequently to aggregate what they had discovered.

Critical Incident 2: Expanding The Inquiry
Process: Because they were meeting frequently and working cohesively, the selection of appropriate systems and foci for analysis emerged from joint discussions. Both group members reported feeling exceptionally proud at their objective analysis and how effectively they reconciled multiple perspectives through debate with each other and with stakeholders. "We aggregated into as many logical human activity systems as possible from all the data we had, all the interviews we did, all the rich pictures, and that kind o f revealed to us the kind of human activity system and how they related to a primary goal or a bigger primary task."
Group roles: From the initial rich picture analysis, the two group members identified more stakeholders to be interviewed, analyzing each stakeholder's perspectives as these emerged. The two group members worked very interactively, dividing data collection and initial analysis, but discussing their criteria for selection of appropriate human-activity system perspectives continually as they worked.

Critical Incident 3: Integrating Evidence Into The Midterm Report
Process: The midterm report became a joint boundary object allowing each individual to critique not only the analysis and presentation of findings from the problem investigation, but also the conceptual construction of relevant systems and the "logical order" of ideas that justified their analysis. This led to an exceptional rich understanding, as debates and disagreements advanced their joint understanding of the situation.
Group roles: The two students collaborated about the production of a joint report, writing a section, critiquing the other's analysis, reordering ideas and subsections, and debating the justification of findings, to reach a shared understanding of both the problem and systemic analysis.

Critical Incident 4: Integrating Evidence Into The Midterm Report
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Critical Incident 5: Post- Midterm "Scaling Up"
Process: The group perceived a need to "scale up" their human-activity requirements in order to provide an implementable set of early requirements for an system of organizational process-change supported by IT. The end of term assignment structure then drove a focus on clarifying section deliverables.
Group roles: One person led this initiative, producing a presentation that was critiqued by the other group member. Once this was produced, the two group members collaborated via email in clarifying deliverables.

Critical Incident 6: Managing documentation of analysis between team members
Process: The group worked collaboratively on the end of term report, "chunking" this into manageable components that were written by one person and developed further by the second.
Group roles: Divide work between team members ("chunking") by section

Critical Incident 7: Producing end of term report
Process: Group work focused on producing a shared vision (a deliverable faculty research system of human-activity and IT support. This was modified as they worked, to include a common interest in information that was required to improve patient care by faculty who used the research information to improve their professional practice.
Group roles: The report was produced through "extensive and intensive collaboration." Team members worked on twelve versions of this report.

Critical Incidents For Group 4

The two members of the final group were both doctoral students, but one was more operationally and instrumentally focused than the other. The first group member (identified as GM-A below) worked as a senior IT manager. The second (identified as GM-B) intended to perform "socio-technical research." There was a mismatch in expectations between the two, that caused some exploration of a suitable inquiry process in the first half of the course.

Critical Incident 1: Initial inquiry
Process: GM-B treated these stakeholder visits as an opportunity for an ethnographic study, whole GM-A treated them as a search for "common patterns or issues." GM-B reported "I was bored with the generic questions we were asking and wanted to explore the differences." GM-A reported that "In the first few interviews we were completely lost as people kept throwing problems at us. We could not negotiate this as everyone was trying to pull us in a certain direction. We were not sure what to focus on."
Group roles: GM-A defined five deliverables to be met through interviews of stakeholders. The two group members jointly derived a script for their initial interviews. They set up a meeting plan that they divided between the two of them; as GM-A was also working for an external organization, they wanted to maximize their use of time. The two group members corresponded by email and met frequently to understand how to analyze the problems that were reported. Their deliberations centered on how to understand the SSM method.

Critical Incident 2: Scoping The First Deliverable
Process: The two group members worked on exploring which problems to explore. GM-A reported that "The initial interviews yielded a laundry list of items that people would like us to solve. This laundry list was not specific to anything, and we could not investigate everything. So we went back to ask where would our time be best spent. What could you as CNHP find useful."
Group roles: GM-A defined the scope of the analysis as the faculty perspective on online teaching and their use technology. GM-B agreed to this focus and the two of them interacted separately with a variety of stakeholders to investigate current processes in this area of work.

Critical Incident 3: Exploring Granularity of Analysis
Process: The two group members debated and worked together to decide how to analyze and model the complexity of information that they were receiving. This was resolved by GM-A, who attempted to apply systems analysis objectives to a complex problem inquiry. GM-B reported "For the first deliverable, the report, we had this issue of granularity … GM-A was pointing for the fine grain lower level and I was going for, I guess I saw some more generalized flows or something. But we went with the lower level perspective."
Group roles: The labor of interviewing and analysis was shared according to availability. Most of the information was obtained individual by email or phone. GM-B reported that "Overall we wanted the whole process to be well-organized so that we don't give the wrong impression to the people we were trying to reach. All the emails sent were copied to each one of us."

Critical Incident 4: Analyzing The Midterm Report
Process: The two group members collaborated on delivering an analysis that was very functionally oriented. Their report merged perspectives, ignoring the requirement to reflect competing perspectives of the problems. Both group members reported that they collaborated in "reconciling inconsistencies" between various stakeholder perspectives. So student needs were lost as the faculty perspective of the main stakeholder contact was privileged.
Group roles: Data collection was performed collectively, as the two group members attempted to follow up and reconcile inconsistencies between different stakeholder perspectives. The analysis of the various human-activity system transformations was split between the two group members, but the report was written collectively. GM-B reported "Working in a group was good, as I would get GM-A's models and I would say it look so different than mine – and then we would have to articulate at an abstract level and find out what's so different than my views of the world, producing this long complicated narrative." GM-A reported, "We did not have conflicting ideas, but we certainly had different ideas. At first we just decided to split the work of drawing conceptual models and meet later.

When we met later we were shocked at how different the level of detail was. That's when we decided on this level of granularity in the models."

Critical Incident 5: Changing Perspectives, A Social Dynamic

Process: The two group members were asked by the instructor to rethink a part of their analysis before they completed the second assignment, to reflect multiple perspectives of the human-activity system, rather than various components of a homogeneous perspective. GM-A challenged this feedback, arguing that their approach was superior in delivering "business value" rather than diversity of perspective. Following instructor examples illustrating ways in which a diversity of perspective was valuable, the two group members attempted to make sense of their analysis by matching the focus displayed in the instructor examples provided. GM-A reported that their prior analysis appeared to be "too generic," while GM-B reported that "we corrected some of the models and brought them to a different granularity."

Group roles: The two group members collaborated on developing their analysis in face-to-face meetings and on collecting more information from their two primary points of contact among the stakeholders. But the social dynamic of the group appeared to change. GM-B reported: "Once somebody recognizes that a prior decision was probably not the best one, the social including of that person, the orientation of the group changes. So for example, GM-A had made that argument for the lower granularity and that turned out not to be the right thing. So for the next decision, there was a preferred view orientation already… according to me, my idea was more comprehensive."

Critical Incident 6: Completing The Final Report

Process: The two group members now followed online faculty discussions and collected more data about the focus of their analysis (online learning systems and technologies). Their emphasis appeared to be on an analysis of effectiveness, collecting statistics on usage and following up faculty problems with the technology.

Group roles: GM-B now appeared to lead the way that the analysis focus and granularity were defined. GM-B reported "I did not want to make that call … it's grounded on the history of the transaction of the group. Not on the logic of the ideas or augmentations." But both group members collaborated well in producing a common analysis through many face-to-face meetings.

Critical Incident 7: Presentation To Stakeholders

Process: This group is unusual in that they separated their presentation to the two sponsoring stakeholders from their analysis for the final report. GM-A reported: "Since they had invested so much time with us, I really want to pay them back with something that was worth their time. Something they could use." GM-B reported "I felt during our final presentation it was s huge struggle, for a long time we didn't have anything to say. And whatever we say in this entire context, we know so little in reality and maybe we could present this in a direction that they could just say, *Oh nice*. At the end, we struck some kind of medium."

Group roles: The two group members worked very closely together to pull out the practical threads from their prior analysis. The presentation and the ideas it represented were reported as reflecting a joint vision.

Changes In Group Inclusiveness and Collective Action Over Time

A major element of the research focus was to explore group cohesiveness, to see if a disruption, or a breakdown to the initial group focus resulted in the involvement of group members in a more inclusive decision-making. Subjects were asked how central they felt to group decision-making and idea-generation at three points in the course (at the beginning, middle, and end). The results are shown in Figure 1, which shows a clear increase in the feeling of participant involvement in decision-making as the course processed. One person felt "uninvolved and unincluded" at the midterm, but this is resolved as the closure focus of the second assignment leads all four groups to involve all group members in defining a vision for their proposed rationale for change. If we examine the levels of group cohesiveness, there was some impact around the time of the breakdown in the larger groups, while the two dyads appeared to retain their current levels of cohesiveness. In Group 1 (the group with least experienced members), cohesiveness was increased as the group faced a new challenge. In Group 2, cohesiveness was reduced, as group agreement of what needed to be done split along expertise-domain fault-lines.

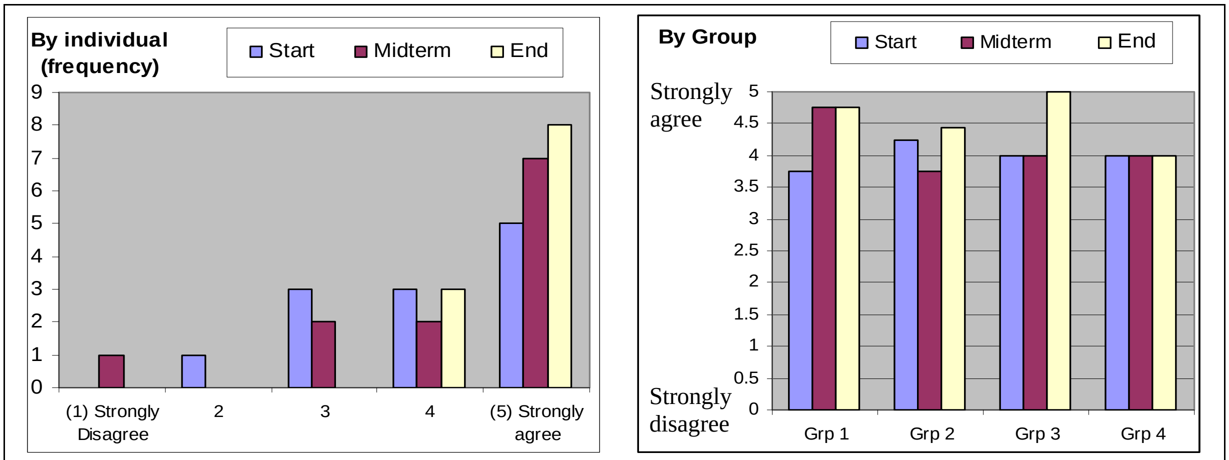

Figure 1. Distribution of Individual Group Members and Group Average Scores, For Members Who Felt Central To Group Decisions At Start, Middle, and End of Course

The second element was to explore whether a disruption, or breakdown in group focus could achieve a wider "requisite variety" of perspectives *(Weick, 1987)*. Group roles and processes were plotted for each group in Figure 2, to determine the degree that a dominant perspective changed, from each critical incident to the next. It would appear that there was very little shared vision across the four groups. The most coherent group appeared to be Group 3. With only two members, they worked collaboratively around a shared vision until the post-midterm disruption, at which one person revised the group focus and the group resumed a relatively collaboratively to deliver a joint analysis and change plan. Group 4 (the second dyad) were dominated by one group member's "recipe for success" until this was found to be ill-matched to the success criteria. The social dynamic then changed to privilege the competing way of working suggested the second group member. The two groups of four members were very different. Group 1, the group with the least collective professional experience of systems analysis and project management, became progressively more collaborative. They appear to have responded to the midterm disruption by deriving a new joint vision and then collaborating around this. In contrast, group 2, whose members had the most diversity of professional experience, appeared to be dominated by the two systems professionals in the group. Even when their collaborative vision was disrupted at the midpoint, these two individuals responded by attempting to carry the original vision through, then distributing planning for each of the original components to provide a more diverse analysis for the final deliverable.

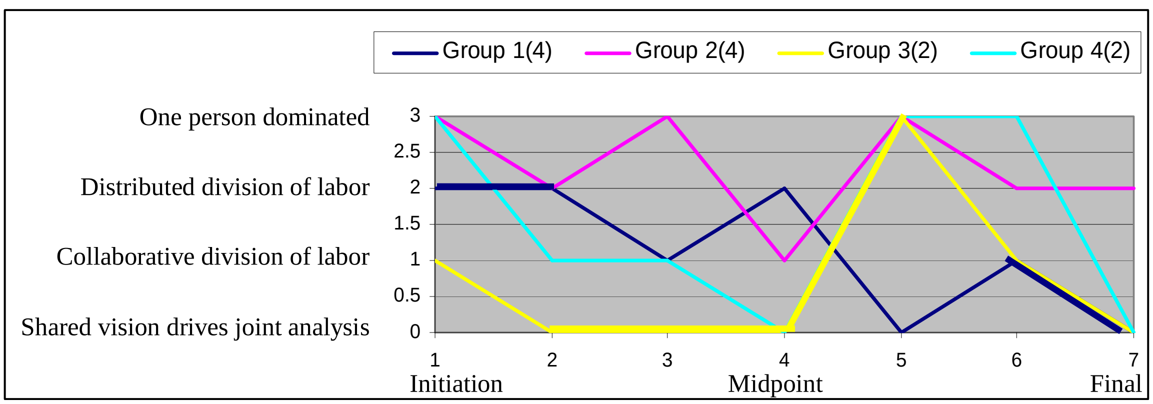

Figure 2. Collaboration vs. Individual Involvement Over The Course of The Project (The number of group members is shown in parentheses after the group ID)

Discussion of Findings

Table 2 summarizes the group outcomes according to three evaluation criteria: the degree of disruption experienced to the group process (low, medium, or high), the complexity of the (assessed as the number of primary-tasks analyzed in detail for process-changes and the average activity-count for each primary-task), stakeholder evaluations of group's proposed process-change and IT system solution, and instructor evaluations (both scored out of 10, with evaluation summary). As real-world early requirements analysis is so complex, it is difficult to provide completely objective evaluation measures. An analysis of participant self-reports provides indications of a major collective breakdown in all groups, with most groups questioning the approach that they were employing to their analysis and attempting to redefine this approach, as well as redefining the outputs of their design.

Table 2. Group Outcome Evaluation

Group	*Size*	*Degree of breakdown*	*# Primary-tasks & Ave. # Activities*		*Stakeholder evaluation*	*Instructor evaluation*
Group 1	4	*Major*: group assumed a "symmetry of ignorance" approach to solution requirements analysis. *Disruption is accommodated*, as group collaborates closely to understand new goals.	8	3.5	8/10 over-complex, but good ideas	8/10 in-depth change analysis with a few gaps. Well-integrated IT system solution
Group 2	4	*Major:* group split along fault-lines of professional experience. *Disruption causes ongoing conflict* about how to proceed with analysis. Group fragments further along occupational role fault-lines, reducing cohesion.	2	13	6/10 IT solution over-focused on one process (student feedback eval.)	7/10 Report fragmented. Detailed process-change analysis, only analyzed small subset of IT solution
Group 3	2	*Major:* group perceives need to change their approach to information-gathering, to explore problems further. *Disruption is accommodated*, as group views analysis as ongoing process of learning.	5	8.5	10/10 wide-ranging, highly integrated process change & IT systems	10/10 highly complex analysis of problem, excellent, integrated IT system solution
Group 4	2	*Major:* group perceives that initial analysis process does not work. *Disruption causes role reversal*, as dominant group member defers to exploratory approach of other one.	9	5.6	7 / 10 process changes perceived as fragmented. IT solution helpful	9 /10 a highly complex analysis of process change, integrated IT solution with gaps

From the summary of Table 2 and the group cohesiveness scores in Figure 1, it would appear that the introduction of a disruption in project goal-setting and analysis processes affected the four-person groups more than the two-person ones. The more cohesive group 1 perceived the breakdown as a challenge, responding collaboratively and increasing group cohesion. Group 2, which was already split on expertise-domain fault-lines, became less cohesive, with ongoing debate and conflict between the two subgroups about how to approach the process of change-requirements analysis. The two dyads appeared to cope with the breakdown more easily, possibly as group coordination was easier. Group 3 collaborated closely in increasing the depth of their analysis, while Group 4, which had been less successful in their initial analysis, reversed roles with the less experienced analyst taking the lead in defining their joint process. All groups achieved a successful solution, to some extent, as shown by the stakeholder and instructor evaluations. Each group tool a different approach to dealing with the breakdown. Group 1 assimilated the disruption, viewing this as one more disruption along an unfamiliar learning experience. Group 2 protested the disruption, with resentment from the software engineers that goals had changed, but eventually assimilated the experience by accepting that the SSM approach required a changing perspective. Group 3 were moved to conduct a more in-depth analysis, but changed course easily and became much more cohesive as a result. Group 4 were forced to change their approach by the combination of initial failure and change in goals. They then produced a highly integrated solution.

The design of this study was intended to produce a collective breakdown in each group's understanding of how to proceed with their IS definition (the situated, high-level design that is often referred to as "early requirements analysis). To ensure that the initial group focus was diverse, the study introduced a "symmetry of ignorance" into each group (Rittel, 1972) by using an unfamiliar, systemic method of analysis. Each group member had to learn new ways of working, becoming unable to call on their procedural "investments in form" (Latour, 1987; Star, 1992): the work-routines, and recipes-for-success derived from their professional experience. *Before the disruption to the project definition*, the explicit process-goals communicated to students were related to the group's exploration of the problem situation, separating interrelated problems out into distinct process goals and their related sets of work-activities, and focusing on differences between the perspectives of various stakeholder groups. As Figure 2 demonstrates, most groups engaged in a relatively collaborative approach to problem inquiry. The need to apply a systemic analysis approach led to a high degree of individual uncertainty, reflected in a relatively bipolar distribution between those group members who felt highly involved in decision-making and those who felt uninvolved. By the midpoint, with one exception, all participants felt relatively involved in group decision-making (Figure 1). Group formation theory indicates that this is to be expected, especially in conditions of high uncertainty (Myers and McPhee, 2006). Group dynamics theory would lead one to expect that dyads would behave more collaboratively than larger groups (Hare, 1981). This was not the case in Group 4, where one member called upon their high status professional experience to define group roles and processes. The same phenomenon was observed in Group 2 (a four-person group), although the effect was weaker in the larger group while the explicit assessment criteria rewarded a diversity of perspectives. Both groups demonstrated a split along experience-related lines, where one or two individuals advocated a normative process based on their prior experience to define appropriate group analysis processes, even when the evidence (instructor feedback) indicated that this was inappropriate. *Following the disruption to the project definition*, the process-goals were related to the group's integration of various stakeholder perspectives, to produce a coherent set of requirements for both business process and IT system change – i.e. an integrationist (as distinct from reductionist) form of problem closure. In response to tight deadlines, each group engaged in a much more distributed way of working, where they often called upon the prior expertise of one or two group members to provide a way to deal with the high uncertainty that this disruption introduced. These different approaches are summarized in Table 2 and appear to be related to two variables: the group size and the degree to which groups were split along domain-expertise lines. Although these findings are exploratory, with a small number of groups, smaller groups appear to be more adaptive following a major breakdown. Where there was a split between group members who lacked extensive software engineering expertise and those who possessed such expertise, the software engineers claimed a superiority of knowledge, using this claim to manage the division of labor, thus controlling group roles and the definition of group processes.

Conclusions

The study provides a detailed view of the different ways in which a procedural "investment in form" (Latour, 1987; Star, 1992) is constructed in newly-formed groups that are thrown into a complex, boundary-spanning problem-situation. It illustrates how collaborative groups construct structures of action when uncertainty is high and time constraints are tight. The findings demonstrate how experienced IS professionals call upon existing recipes for success in such circumstances, outweighing considerations of flexibility and adaptiveness, *even when these attributes of a solution are explicitly rewarded*. Experienced IS professionals appear to respond to the high levels of uncertainty that this introduces by calling upon the authority of their technical domain analysis expertise to control the division of labor, which in turn establishes structural role-definitions for individuals within the group. This finding confirms the finding of a previous field study of design in groups involving technical and non-technical areas of expertise (Gasson, 1999).

Although this is an exploratory study, conducted with a small number of participants, it provides rich insights into processes that are largely unobserved, except in controlled experiments which do not mirror real-world settings. We know little about how IS professionals, who are constantly assigned to new projects, with new people, adapt their practices in conditions of high uncertainty and "thrownness" (Weick, 2004). The role of collective breakdowns in design appears to hold promise only if we can manage the automaticity in analysis that is provided by existing procedural investments in form. This may be possible if we can locate some way to challenge the engineering "thought-rails" that dominate some aspects of our profession meaningfully. Time constraints and the need to manage uncertainty appear to override the need for effective, wide-ranging solutions. This can be managed with active intervention from a process expert (as it was here, employing instructor feedback). But where individuals have a strong engineering orientation, or a high-status IS management background, they may be so used to applying procedural investments-in-form that it may be difficult to disrupt this automaticity, even when the reward structure is designed to penalize reductionism. The contribution of this paper is to suggest a mechanism for introducing productive, collective breakdowns into boundary-spanning systems definition and to demonstrate the mechanisms that permit this to be successful or to fail. Two variables appear to be important in managing group response to breakdowns: group size and the degree to which groups were split along domain-expertise lines. Further studies will examine the impact of managing these variables, or structuring outcome evaluation criteria in different ways, to reward diversity and process improvisation to obtain an understanding of how to improve the processes that we employ for early requirements analysis of boundary-spanning information systems.

References

Baskerville, R.L. and Wood-Harper, A.T. "A Critical Perspective on Action Research as a Method for Information Systems Research," *Journal of Information Technology* (11) 1996, pp 235-246.

Bergman, M., King, J., and Lyytinen, K. "Large Scale Requirements Analysis As Heterogeneous Engineering," *Scandinavian Journal of Information Systems* (14) 2002, pp 37-55.

Boland, R.J. and Tenkasi, R.V. "Perspective Making and Perspective Taking in Communities of Knowing," *Organization Science* (6:4) 1995, pp 350-372.

Butterfield, L.D., Borgen, W.A., Amundson, N.E., and Maglio, A.T. "Fifty years of the Critical Incident Technique: 1954 – 2004 and beyond," *Qualitative Research* (5:4) 2005, pp 475-497.

Checkland, P. *Systems Thinking Systems Practice.* John Wiley & Sons, Chichester UK, 1981.

Corbett, J.M. "IT And Work Design: The Negotiation Of Expertise," in: *The Management of Expertise,* S. H. (ed.), MacMillan, London UK, 1995.

Dorst, C.H. and Cross, N.G. "Creativity in the design process: co-evolution of problem–solution," *Design Studies* (22:5) 2001, pp 425-437.

Flanagan, J.C. "The Critical Incident Technique," *Psychological Bulletin* (1:327-358) 1957.

Gasson, S. "The Reality of User-Centered Design," *Journal of End User Computing* (11:4) 1999, pp 3-13.

Gasson, S. "A Genealogical Study Of Boundary-Spanning IS Design," *European Journal of Information Systems* (15:1) 2006, pp 26-41.

Hare, A.P. "Group Size " *American Behavioral Scientist* (24:5) 1981, pp 695-708.

Heidegger, M. *Being and Time.* Harper & Row New York, New York NY., 1962.

Karsten, H., Lyytinen, K., Hurskainen, M., and Koskelainen, T. "Crossing boundaries and conscripting participation: Representing and integrating knowledge in a paper machinery project," *European Journal of Information Systems* (10:2) 2001, pp 89-98.

Latour, B. *Science in Action.* Harvard University Press, Cambridge MA, 1987.

Lau, D.C. and Murnighan, J.K. "Interactions Within Groups And Subgroups: The Effects Of Demographic Faultlines," *Academy of Management Journal* (48:4), 08 2005, pp 645-659.

Lave, J. and Wenger, E. *Situated Learning: Legitimate Peripheral Participation.* Cambridge University Press, Cambridge UK, 1991.

Markus, M.L., Majchrzak, A., and Gasser, L. "A Design Theory For Systems That Support Emergent Knowledge Processes," *MIS Quarterly* (26:3) 2002, pp 179-212.

Myers, K.K. and McPhee, R.D. "Influences on Member Assimilation in Workgroups in High-Reliability Organizations: A Multilevel Analysis," *Human Communication Research* (32:4) 2006, pp 440-468.

Rittel, H.W.J. "Second Generation Design Methods," Reprinted in N. Cross (ed.), *Developments in Design Methodology,* J. Wiley & Sons, Chichester, 1984, pp. 317-327., Interview in: Design Methods Group 5th Anniversary Report, DMG Occasional Paper 1, pp. 5-10.

Rosenbrock, H.H. "Engineers And The Work That People Do," *IEEE Control Systems Magazine* (1:3) 1981, pp 4-8.

Schein, E.H. "A General Philosophy Of Helping: Process Consultation," *Sloan Management Review; Cambridge; Spring 1990* (33:3) 1990, pp 57-64.

Schön, D.A. *The Reflective Practitioner: How Professionals Think In Action.* Basic Books, New York NY, 1983.

Star, S.L. "The Trojan Door: Organizations, Work, and the 'Open Black Box'," *Systems Practice* (5:4) 1992, pp 395-410.

Turner, J.A. "Understanding The Elements Of Systems Design," in: *Critical Issues In Information Systems Research,* B. R.J. and H. R.A. (eds.), Wiley, New York, NY, 1987, pp. 97-111.

Weick, K.E. "Organizational Culture As A Source Of High Reliability," *California Management Review* (29:2) 1987, pp 112-127.

Weick, K.E. "Designing For Throwness," in: *Managing as Designing,* R. Boland, J and F. Collopy (eds.), Stanford Uniersity Press, Stanford CA, 2004, pp. 74-78.

Wilson, B. *Soft Systems Methodology: Conceptual Model Building and Its Contribution* Wiley, Chichester, 2001.

Winograd, T. and Flores, F. *Understanding Computers And Cognition.* Ablex Corporation, Norwood New Jersey, 1986.