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Social Interactions of Information Systems Development Teams: A Performance Perspective

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Social Interactions of Information Systems Development Teams: A Performance Perspective

Suggested running head: Social ISD

Abstract

We report results from a longitudinal study of information systems development (ISD) teams. We use data drawn from 60 ISD teams at 22 sites of 15 Fortune 500 organizations to explore variations in performance relative to these teams' social interactions. To do this we characterize ISD as a form of new product development, and focus on team-level social interactions with external stakeholders. Drawing on cluster analysis we identify five patterns of team-level social interactions and the relationships of these patterns to a suite of objective and subjective measures of ISD performance. Analysis leads us to report three findings. First, data indicate that no one of the five identified pattern maximizes all performance measures. Second, data make clear that the most common approach to ISD is the least effective relative to our suite of performance measures. Third, data from this study show that early indications of ISD project success do not predict actual outcomes. These finding suggest two issues for research and practices. First, these findings indicate that varying patterns of social interactions lead to differences in ISD team performance. Second, the findings illustrate that singular measures of ISD performance are an oversimplification, and that multiple measures of ISD performance are unlikely to agree.

INTRODUCTION

Through this paper we extend current theorizing regarding information systems development (ISD) by exploring the performance implications of various patterns of social interactions among those who develop information systems (IS). We note that social interactions have long been seen as a dominant aspect of ISD (e.g., Weinberg, 1971; Brooks, 1974; Walz, Elam and Curtis, 1993; Russo and Stolterman, 2000; Kautz and Nielsen, 2004). And, variations in these social interactions are able to explain performance differences among ISD teams (e.g., Agerfalk and Eriksson, 2006; Hirschheim, et al., 1991; Curtis, et. al., 1988). Some have even argued that the social aspects of ISD often overshadow the substantial technical complexities (e.g. Keil, 1995; Newman and Robey, 1992; Robey and Newman, 1996). The details of the relationships among social interactions and ISD performance are still not well understood empirically or theoretically. Our intent is to close this gap and here we report findings in support of this research question: *How do specific patterns of social interactions during ISD effect performance?*

We draw on data from 60 ISD teams at 22 sites of 15 Fortune 500 companies. These data were gathered using a set of five surveys drawn from each ISD team at three points in time:

following requirements determination, at implementation, and three-to-six months post-implementation. To help us characterize and explore relationships among social interactions and ISD performance we use cluster analysis (as have other scholars in the field of information systems, see Sabherwal and Robey (1993; 1995)). As noted below in more detail, cluster analysis is a set of techniques that can be used to explore underlying patterns of relationships based on pre-defined attributes. In our case these clustering attributes are some of the social activities and performance measures of ISD teams.

The paper continues with the following section containing our conceptualization of ISD, focusing on the roles of external-to-the-team social interactions. This is followed by sections in which we describe our research model, research design and data collection; report a summary of findings; and present a discussion of the implications of this work for research and practice.

CONCEPTUALIZING INFORMATION SYSTEMS DEVELOPMENT

Developing an IS requires broad knowledge of the intended domain, exacting knowledge of data structures and processing logic, and disciplined knowledge of how best to develop software (Iavari, Hirschheim and Klein, 2004). This is typically done via teams. For purposes of the research reported here, an ISD team is two or more software developers who build a defined product to be delivered within a certain time-frame. By “software developer” we mean here a range of roles such as programmer, analyst, system tester, database administrator, domain expert seconded to the ISD team, and the team’s technical leads and project managers.

An ISD team relies on the collective skills of its members because the inherent complexity and scope of the effort needed to develop software normally exceed the ability of any one person. These tasks range from the semi-structured efforts used to gather requirements, the detailed and exacting steps of logical design and programming, and the disciplined steps of testing and integrating the software modules (Walz, Elam and Curtis, 1993).

A Social Perspective on ISD

Our perspective on ISD is *social* (e.g., Kautz and Nielsen, 2004; Russo and Stolterman, 2000; Newman and Robey, 1992; Robey and Newman, 1996; Hirschheim, Klein and Newman, 1991). A social perspective focuses attention to how IS developers work together to produce software. Social aspects of ISD include informal communication among members and intra-group activities such as discussing how activities will be performed, finding -- and taking -- the time to talk with other team-members, sharing of ideas and information, and resolving the conflicts that arise in the course of working together (Kirsch, 1996). The social aspects of ISD also include coordinating with non-team members; managing the flow of information across the semi-permeable boundaries that define who is – and is not – on the ISD team; and making allies with and managing resources shared with other teams (Guinan, Cooprider and Faraj, 1998).

Other perspectives on ISD include *production, individual, political* and *contextual*. The *production* perspective is the most common and its focus highlights the roles of particular methods, techniques, and tools (e.g, Thayer, 2000). The *individual* perspective focuses on the unique contributions of individuals to the team (e.g. Curtis, Hefley and Miller, 1995; Weinberg, 1971; Shiel, 1981). The *political* perspective engages power relations among stakeholders (e.g. Markus and Bjorn-Anderson, 1987; Kling and Iaconi, 1984). A *contextualist* perspective engages issues such as organizational competitiveness, the industrial milieu in which the company operates, the degree of managerial skill, the level of resources, and other extra-organizational factors (e.g., Nambisan and Wilemon, 2000; Gillette and McCollom, 1990). Focusing on ISD from a social perspective may mean de-emphasizing (but not de-valuing) those factors highlighted in contextual, production, political and individual approaches.

The Social Activities of ISD

For three reasons, we draw on the small group research that is focused on new product development (NPD) to help conceptualize the social activities of ISD. First, as in NPD, an ISD team's intent is to produce a product for use by others. In the case of ISD, the product is the software-based IS delivered to users (Nambisan, 2003). Second, both NPD and ISD teams are characterized by boundary-spanning behaviors (Hansen, 1999; Nambisan, 2003). By boundary-spanning behaviors we mean actions that members of the team make to connect to external stakeholders: people who are outside of the team, such as sponsors, customers and specialists (Ancona and Caldwell, 1990; Namisan and Wilemon, 2000). Third, both NPD and ISD teams engage similar tasks and this similarity in task makes the team's structure and activities comparable (Sole and Edmundson, 2002; Nambisan, 2003; Hansen, 1999; MacCormack, Verganti and Iansiti, 2001).

Social activities of a team's members are either internally or externally focused. The ISD team literature typically highlights the importance of internal social interactions (Walz, et al., 1993). However, in NPD, the external-to-the-team (or boundary-spanning) activities of the team's members are often highlighted as these connect the team's members to others in the organization (and other larger social structures) in which the team exists (Joshi, 2006; Cross, Yan and Louis, 2000; Ancona, 1990; Ancona and Caldwell, 1992).

We focus on the boundary spanning aspects of the ISD team's social activities for three reasons. First, we highlight that team members must make a choice to spend their time and energy on either internal or external issues (see also Curtis, Krasner and Iscoe, 1988; Guinan, Cooprider and Faraj, 1998). It is a zero-sum choice since a team's resources are finite and both aspects of the social interactions must be attended (e.g., Joshi, 2006; Ancona and Caldwell, 1998). Second, the current wisdom regarding ISD is that external-to-the team activities such as keeping users involved and managing stakeholder expectations will lead to higher levels of user satisfaction and better IS (Cavaye, 1995; Ginzberg, 1981; Lakhanpal, 1993). Third, evidence from the NPD literatures indicates that teams who better manage their external dependencies perform better than those that only manage their internal dynamics (Ancona and Caldwell, 1992; Edmondson and Sole, 2002).

One means of encouraging communication across boundaries is to develop special boundary-spanning roles (Thompson, 1967; Aldrich and Herker, 1977; Gladstein, 1984; Bartel, 2001). Ancona (1990) and Ancona and Caldwell (1992), in their work on NPD teams, identified five boundary spanning activities: ambassador, scout, guard, sentry and coordinator. These roles are rarely exclusive to a person, or fixed to a person over time. Rather, they represent activities that members of the team take on as needed, and these roles may be explicitly or tacitly assigned.

Ambassadorial activities are those aimed at representing the team to its external constituents. Individuals performing ambassadorial activities serve as key nodes in the organization's formal organizational hierarchy and obtain feedback about team progress while negotiating for additional time and resources from others in the organization. Ambassadors build support for their team by providing favorable reports to outsiders; report the team's progress to those higher in the organization; and intercede in the face of external opposition.

Scouting is the activity of crossing the team's borders to bring back information about what is going on elsewhere in the organization. Scouting can include scanning about external markets, searching for new technologies, identifying relevant activities outside of the team, and uncovering pockets of potential competition.

Guard and sentry activities serve to protect the team by allowing team members to work with minimal distraction. Guards keep information and resources inside the group. Guards monitor requests for information or resources by outsiders and help determine what the group will release in response to those demands. Sentries serve to "police" the team's boundary by controlling the information and resources that outsiders want to send the team. Guards and sentries essentially act as filters, deciding what will be the flow of input to and from the team's members.

Finally, coordinators focus on communicating across, rather than up and down, the organization. Coordinator activities include discussing design problems with others, obtaining feedback about team progress from external sources, and planning events such as negotiating for additional time or resources from other comparable work groups.

ISD Performance

There have been a variety of measures proposed and/or used to evaluate the performance of ISD teams and each of which has its own strengths and weaknesses (Espinosa, Delone, and Lee, 2006; Delone and McLean, 2003; Lakhanpal, 1993; DeLone and McLean, 1992). For our purposes ISD performance is multifaceted and no one measure captures the totality of this effort (Keen, 1980; Melone, 1990). Thus, we use a suite of performance measures, discussed below.

One common performance measure is stakeholder assessment. As noted above stakeholders are individuals who are not team members but who influence the development activities and/or are affected by the resulting IS. Stakeholders typically assess team performance based on their knowledge of the organizational needs, experience with previous and ongoing ISD projects, and their expectation of quality work (Seidler, 1974; Henderson and Lee, 1992; Guinan, Cooprider and Faraj, 1998).

Since team members are often the most knowledgeable about the specific activities of the development, our second performance measure is their self-evaluation of the team. Performance assessments often vary across constituent groups, as they have different interests and experiences

(Tsui, 1984). It may be that team members are more interested in creating a more task-oriented environment, while stakeholders are more interested in the specific outputs generated by the team. In addition, team members have a constant stream of information about team interaction and can use that to evaluate performance. Building on the IS tradition, we include user satisfaction in our suite of ISD performance measures (Bailey and Pearson, 1981; Ives, Olsen and Baroudi, 1983; Doll and Torkzedah, 1988). This provides a customer or user evaluation of the ISD team's effort.

As a point of comparison with the previous measures we include two more traditional evaluations of ISD performance: labor productivity and user satisfaction. Labor productivity arises from viewing ISD as a production effort and we measure the development team efficiency by dividing an assessment of the total system functionality (measured in function points, see IFPUG, 2001) by the total labor costs for the system development effort. User satisfaction is measured several months following the take-up of the newly implemented IS.

THE RESEARCH MODEL

In Figure 1 we present our conceptualization of ISD team's boundary spanning activities and measures of performances against the data collection time line. Per both Weick's (1995) and Sutton and Staw's (1995) guidance, since we are not hypothesizing specific relationships, there are no arrows in the figure. Rather, we focus here on identifying some overall patterns of activities and the performance impacts of these patterns. Appendix A contains operational definitions of the variables used in this study, the items used to develop these variables and each resulting scales' reliability estimate (using the alpha measure, see Cronbach, 1951). In this section we describe the generic ISD model, map to it the boundary spanning activities of ISD teams, and detail our characterization of ISD performance

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Insert Figure 1 about here

A Generic ISD Production Model

We use a generic model of ISD characterized by three broad types of activities: requirements determination, IS development, and post-implementation use (which we define in more detail, below). These three activities have traditionally been conceived as being linear (requirements precedes development, and use follows). However, these three activities might be engaged iteratively or even concurrently depending on the particular ISD method employed. The generic ISD production model is premised on the beliefs: (1) that these three activities can be identified independent of any one ISD method and (2) these activities can be identified (by the participants).

Given our focus on the social aspects of ISD, a generic model focusing on high-level depictions of activities is an adequate representation of ISD. Moreover, our data collection strategy allowed for the team leaders to define the movement from one activity to the next. Thus, it is quite likely that some development work began before requirements were completed, and that requirements definition continued during the development phase. Depicting the myriad approaches and paths that working teams pursue do develop IS into three broad activities is a justifiable, but possibly limiting, research design decision[1].

In the requirements determination stage, the IS's specifications are determined and a document produced that contains the agreed-upon specifications. This stage is characterized by extensive information sharing among developers and stakeholders. This information sharing reduces ambiguity about the needs of the resulting IS; helps to assure the quality of information sources used by the ISD team; and develops shared meanings (collective mind) among both stakeholders and the ISD team's members (Crowston and Kammerer, 1998).

The development stage includes design, coding, testing, installation of the system and the

[1] One reviewer has argued that this generic ISD production model implicitly advocates for a 'waterfall' approach. We note that, in allowing teams to specify when they moved from one activity to another, we allowed for methodological variations. Moreover, the ordering of these three stages serves as part of the study's conceptual frame (see Lucas, Ginzberg and Schultz, 1990). Thus, it is possible that the research design biased data collection towards traditional or waterfall approaches (and we discuss this later in this paper). We further acknowledge that these stages are temporal and any one team's movement through these stages is tied to their specific calendar (e.g., Langley, 1999). Likewise, the generalized model of an ISD team's social activities is also temporal and not tied to a specific calendar. In contrast to ISD works such as Walz, et. al., (1993), our approach provides a means for comparing team's external social activities, and their ISD performance, across a number of teams.

training of its users. In this phase, interactions among the ISD team's members focus on translating needs into the design, discussing how to turn the design into executable code, and ensuring that the different modules of code operate together, without error, while meeting the user's requirements. Additional interactions with stakeholders are often needed to clarify unresolved (or emergent) issues, to prepare and conduct the installation and training effort, and to help users understand what they will be receiving. This stage ends when implementation (the installation of the IS and training of relevant personnel) is completed.

Since there is no specific time point where post-implementation use transitions to a steady state (or habituated) use level, our selection of three-to-six months was pragmatic. That is, the sponsors of the research, and later the various teams at the sites who volunteered to participate, agreed with our assessment that a three-to-six month post-implementation period would allow users to form their perceptions of IS use and value.

Boundary Spanning Activities during Requirements Determination

We conceptualize requirements determination as characterized by the need for extensive boundary spanning, rapid changes in the information bases of both stakeholders (such as end users) and developers, and careful attention to the movements of information across the ISD team's boundary. Evidence suggests that ISD teams will exhibit higher than typical levels of ambassadorial activities as these help to spread the good word about the ISD team (Kling and Iacono, 1984; Markus and Andersen, 1987). Other evidence indicates that scouting activities are particularly important in the early stages of new product development (Ancona and Caldwell, 1990). We maintain that this is also likely for ISD teams during requirement determination. It is an appropriate time to scan the environment for alternative views of the proposed system, to determine the most appropriate computer-assisted tools to use in the project, and to examine the external influences on project success.

Contemporary research on ISD teams further suggests that high levels of guard and sentry activity may hinder the team during requirement determination (Guinan, Cooprider and Faraj, 1998). Finally, in the ISD context, coordinator activities reflect some of the critical tasks required of project managers or team leaders who must negotiate for shared resources with other ISD teams. (Brooks, 1975). For instance, project manager often compare performances of one team to another, and seek help from other project leaders on different but comparable projects. What may not occur is the sharing of information among team members of different projects. This is due largely to the time constraints of the typical software project (Boehm, 1987; 1991).

Performance at Requirements Completion

Variations among the team's internal and boundary spanning activities during requirements determination should affect the performance of the ISD team. A consistent theme in the ISD literature is that requirements determination is a very difficult and important part of development (Boehm, 1981; Holtzblatt and Beyer, 1995). It seems reasonable to conclude that a poor job at requirements definition will have significant and negative impact on both the effectiveness and the efficiency of the resulting system (Canning, 1977; Boehm, 1981; 1987). Currently, errors in initial system requirements are believed to be largely responsible for the cost and schedule overruns that are still frequent in software development. Boehm (1981), for example, states that the cost of correcting erroneous requirements of an operational system is at least a hundred times greater than correcting them during requirements determination. And, for nearly 25 years, we have known that user dissatisfaction with systems can often be traced directly to poor requirements determination (Andrews, 1983).

Boundary Spanning Activities during Systems Development

Following requirements completion, ISD teams typically focus on developing the software. However, the project's requirements change as the evolving IS is prototyped, explained or presented to various stakeholder and user groups. This means that team members remain involved in maintaining their external-to-the-team relationships with stakeholders and users.

As the time to implement draws near, ISD team members typically increase their boundary spanning activities. This increase is driven by the need to prepare the users to receive and use the new IS being delivered. However, the form and manner of this increased boundary spanning activity may be driven in part by the team's performance during requirements determination. Three scenarios reflect this temporal relationship between implementation and requirements.

In the first scenario, stakeholders' reactions to the project at requirements completion are favorable. As a result, during implementation, it is likely that the stakeholders will make fewer demands of the team. This means the ISD team members perform less boundary spanning during the development phase. During the pressures of implementation deadlines, members of these teams may prioritize internal needs over external needs.

A second scenario begins with stakeholders' reactions to the project at requirements completion having been unfavorable. The stakeholders are likely to be suspicious of the team member's actions and performance as the ISD effort moves into development. Therefore the stakeholders will expect more interaction with the ISD team during implementation, demanding more boundary spanning efforts (for example, requiring more project review meetings and project status reports). The ISD team members are forced to respond to stakeholder expectations and demands by exhibiting more ambassador and scout activities while simultaneously trying to protect their own interests by exhibiting more sentry and guard activities.

A third scenario, and the most plausible if much of the professional and some of the academic literature is to be believed, is that requirements continue to evolve or even emerge during development (e.g., Truex, Klein and Baskerville, 1999). This implies that users and developers continue to interact to pass on changes and make sense of what these changes mean for design. Further, ISD team members must also speak with other stakeholders such as funders and sponsors. In this, the scope-creep, scenario, levels of ambassadorial, coordinator and scout activities will remain high (and may even increase) though guard and sentry activities may drop.

Implementation, Use and Post-Implementation Performance

Post-implementation assessments of performance are considered to be more robust than those measured at implementation and, as we noted, multiple means of assessing performance are thought to provide a better picture of ISD performance than are singular measures (Melone, 1990; Guinan, Cooprider and Sawyer, 1997). The ISD team's performance is assessed by both the team member's self-evaluation of their effectiveness and stakeholder ratings. Stakeholder ratings of effectiveness at implementation draw on the same people and the same instrument used at requirements determination. At this time the labor costs were collected and, along with the function point counts, the ISD team's labor productivity was determined. In addition, a team of researchers, trained in function point counting, estimated the delivered IS's function points soon after implementation. Function points were chosen as a measurement because they reflect system functionality (not size). Several of the research sponsors were also collecting function point data (allowing us an additional means to validate the counts). Three-to-six months after the implementation, users were asked to rate their satisfaction with the new system.

RESEARCH DESIGN AND DATA COLLECTION

We use a repeated cross-sectional, field-based, survey design for this research (Selltiz, Jahoda, Deutsch and Cook, 1959). A repeated cross-section approach means that at each data collection time we gathered data from different people who held similar roles. By field-based we mean that we surveyed practicing professionals working on active ISD projects. Given the turnover of personnel on these teams, it was not possible to ask the same people to complete the surveys at each data collection time. Thus, this is not a panel design. Further, since the team is the level of theory, measurement and analysis, a role-oriented collection plan is reasonable (Klein and Kozlowski, 2000).

Data Collection

Data were gathered using mail-based surveys, phone-based surveys and visits by the research team. The six survey instruments were used to gather data from the ISD project team members, their stakeholders, and users (see Table 1). All six surveys were both pre-tested and pilot-tested following Dillman's (1978) guidance. The two surveys used to collect data from developers were mail based, as was the user survey. The ISD project leader and the two stakeholder surveys were phone-based. Questions on all surveys were targeted at the team level.

Insert Table 1 about here

Responses from the developers and users were treated as confidential and anonymous. The ISD project leader and stakeholder data could not be collected anonymously, since we had to know their names to ensure that data were collected. But, their responses were confidential. To protect identities, we coded organizations, teams and individuals with random numbers. All participants knew that data would be reported only as anonymized team-level aggregates.

Data collection was done from 1991-1994[2]. Data collection happened three times across the

ISD project for each team (see Figure 1): requirements, implementation, and post implementation. As noted above, data collection was not tied to our calendar but based on the particular chronology of each participating ISD team. To achieve this goal, team leaders and researchers interacted on a frequent basis and data collection was initiated when the team's leader indicated to the research team that they had reached the end of a stage.

The first survey, focused on ISD team members, was administered at the end of each team's requirements determination stage. For each of the 60 ISD teams in this sample, from three to five people completed this survey. The second ISD team member survey was administered after each team completed system implementation. For each of the teams in this sample from two to four people completed the survey. Both of these paper-based, self-administered, surveys used identical scales to measure the boundary spanning constructs. Prior to this, each team's leader was asked to provide representation of senior and junior members and a variety of technical expertise and project leadership roles as a form of key informant sampling (Seidler, 1974; Henderson and Lee, 1992; Lee, Goldstein and Guinan, 1991).

For each project, stakeholder data were gathered at the conclusion of both requirements and implementation. From one to three stakeholders provided data for 52 teams at the end of requirements. At implementation from one to three stakeholders provided data for 47 teams. The fifth survey instrument was administered to the end-users of the IS after three-to-six months of active use following the systems' implementation. Typically, those who completed this survey had no direct contact with the developers except at this time.

Following implementation the specific IS's function points were counted for each project. We used function points to allow a comparison among ISD projects since it allows comparison on common measures of functions that an IS can perform. Function points were counted using two-person teams trained to use a common standard to ensure comparability of results. These two-person teams were comprised of graduate students trained to use the International Function Point User Group (IFPUG) 3.2 standard. Students independently counted function points and then reconciled differences for a final count. Further, at this time the ISD team leader was asked via a phone survey for data about ISD project costs and labor rates. Only 40 teams provided us with project cost and labor data.

Sample Characteristics

The sample used in the analysis reported in this paper come from 60 ISD teams, each located at one of 22 sites of 15 organizations in the US and Canada. While the sample is not randomized, we believe it is representative of practice. It was certainly not convenient. The 15 participating organizations were part of an initial pool of 30 (all in the Fortune 500 at the time). These 30 organizations were originally identified by the research team in concert with the research sponsors based on three criteria. First, the organization's ISD group had to be large (more than 300 people). Second, they had to be seen (using one of three industry publications of the time) as a thought-leader in ISD. Thought leadership means here that the organization was considered one of the top IS places to work, was noted in the professional press for innovation, or had been rated as a top IS department by their peers. Third, the organization had to provide access to at least four teams over the duration of the project. For a variety of reasons, 15 of the original 30 organizations identified chose to not participate. The primary reason for declining participation was the extensive time and effort commitment required.

The 15 organizations, 22 sites and 60 teams in this sample volunteered to participate in the study. They were briefed on the extensive participation requirements before volunteering. These requirements included completing several lengthy surveys, participating in phone interviews, maintaining contact (by phone or visit) with a research team member every three-to-four weeks over the course of the ISD effort, and providing access to project documents, end users and senior managers. We estimated (correctly) that the total resource effort for each team would be more than 200 person-hours across the ISD project.

Contributing organizations represented financial services (7), manufacturing (3), and high-technology industries (5). Three organizations provided access to more than one site. To control for project scope, the ISD projects had to be 12-to-18 months in *planned* duration. The actual length to completion of the projects in this sample ranged from 18 to 31 months. The mean time to completion was 22 months. Projects had to be traditional IS efforts with strategic relevance to the company. The traditional focus meant that we chose to exclude projects focused on developing IS exclusively for commercial sale and projects where new technologies or methods were being tried for the first time.

Candidate ISD teams were first identified by each site's senior IS managers after being briefed by the research team on the commitment required. The ISD teams were then approached to secure their voluntary participation. More than 120 ISD teams volunteered, but attrition (primarily through project cancellation) reduced the number to the 60 on which we report[3].

ANALYSIS AND FINDINGS

Data collection instruments were specifically designed to be collected at the individual level and then aggregated (by averaging responses of the team's members) to the team level for analysis (James, 1982; Jones and James, 1979; Klein, Danserou and Hall, 1994; Klein and Kozlowski, 2000). In Table 2 we present the means and standard deviations for the variables measured. In Table 3 we present the correlations among the measured variables. In order to justify aggregating data from the individual to the group level, each variable's within-group and between-group variance was assessed using one-way analysis of variance.

Correlations reported in Table 3 also illustrate the complex relationship among the ISD performance variables. For instance, stakeholder ratings of effectiveness at requirements have a significant, positive, relationship to both team and stakeholder ratings of effectiveness at implementation. However, there is no relationship between requirements effectiveness and user satisfaction. There is also a significant negative relationship between stakeholder ratings of effectiveness at requirements and the labor productivity of the project. We return to this below.

Insert Table 2 about here

Insert Table 3 about here

Interpreting the Social Interactions and Performance Patterns of ISD Teams

To explore potential relationships among boundary spanning activities and the multiple measures of ISD performance we used cluster analysis as other possible approaches (such as split sample analysis using either multiple regression or structural equation models) were constrained by the relatively small sample size and the exploratory nature of this work. Cluster analysis is well-suited to exploratory work focused on identifying potential patterns of relationships among variables (Morrison, 1967; Haire, Anderson, Tatham and Black, 1998; Pedhauzer and Schmelkin, 1991). Cluster analysis is actually a suite of analytic techniques that are used to first calculate patterns of relationships among identified attributes and then to group them based on the magnitude of similarity among identified attributes. Cluster analysis is focused on creating groupings, and will always return a cluster (even if the groupings are tenuous). This means that the formation and interpretation of the clusters must be seen as exploratory. Clustering is often used in nascent attempts to identify patterns. It is commonly used in genomics, software engineering and marketing to detect and represent patterns in large groups of data. In IS it has been used to explore implementation practices (e.g., Sabherwal and Robey, 1993).

In our analysis, we use the two sets of five boundary spanning constructs (from requirements and implementation) to explore patterns of variations relative to the five measures of ISD performance. As the basis for determining clusters, we used the squared Euclidian distance between the projects as a measure of the distance (Milligan and Cooper, 1986a, 1986b; Haire, Anderson, Tatham and Black, 1998). The squared Euclidian distance between two projects is calculated by summing the squared distances between any two projects over all 10 variables.

We used the “complete linkage” or “furthest neighbor” technique to determine how to combine clusters at each step of the analysis (Milligan and Cooper, 1986a; Morrison, 1967; Hair, Anderson, Tatham and Black, 1998; Pedhauzer and Schmelkin, 1991). In this approach, the distance between two clusters is calculated as the distance between their two furthest points. Clusters are combined at each step based on their being closest together. The complete linkage technique is the most commonly used approach. And, given the relatively small number of data points, it is also computationally possible (Milligan and Cooper, 1986b). The complete linkage technique highlights the distance among clusters and maximizes the distinction of one cluster from another, which is exactly what we were seeking from the cluster analysis. In contrast, average linkage approaches tend to produce clusters that minimize the variance across clustering variables while Ward's linkage tends to minimize the differences across the means of the clustering variables (Hair, et. al., 1998, pp. 495-496). The resulting clusters are typically difficult to interpret.

As is common in cluster analyses, we examined the fusion coefficients at each agglomerative stage to determine the number of clusters (Milligan and Cooper, 1986a, 1986b; Hair, et. al., 1998). Since there is no test for this determination, we used the common heuristic that the number of clusters is best decided by visually inspecting for large decreases in the agglomeration fusion coefficients (see Sahberwal and Robey, 1993 and Hair, et. al., 1998, p. 499). This occurred in the step from five to six clusters, leading us to select the five cluster model.

Results of the five cluster analysis are shown in Table 4. Since a cluster analysis will always find clusters, interpreting the meaning of clusters is an act of theorizing (Weick, 1995) and this is the specific intent of this paper. In Table 4 we present the mean values of the 10 independent variables and the mean values of the performance variables for each of the five clusters. The last column contains the sample means (reproduced from Table 2) to allow for comparison. To determine the significance of the cluster's means for each variable, we conducted a t -test comparing each variable in each cluster to the aggregate of all other teams in the sample that are not in that cluster (Scheffe, 1959, p. 73).

Insert Table 4 about here

Cluster 1 – Borrowers: We name these teams borrowers because of their focus on scouting for other information. Borrower teams have nearly average levels for the boundary spanning variables during requirements determination, with scouting the exception. Scout and coordinator activities are significantly higher than the mean in development while guard and sentry activities are significantly lower than the mean during this period. These teams have significantly lower labor productivity (they are not very efficient) than the sample mean. The other performance variables are not significantly different from the sample means.

Cluster 2 – Isolationists: These teams were so-named because of their limited boundary spanning activity. Members of these teams do significantly less boundary spanning than the sample average during both the requirements determination and development phases. Performance variables for these teams are statistically undifferentiated from the sample average.

Cluster 3 – Insulators: These teams' boundary spanning activities decline during development, suggesting a withdrawal from contact with external constituents. Insulator teams exhibit average levels of boundary spanning during requirements determination, and significantly less than average levels of boundary spanning during development. Insulators have significantly higher-than-the-mean labor productivity (they are efficient) though they are statistically non-differentiable on the other performance measures.

Cluster 4 – Politicians: These teams earned the label politician because of the increasing level of boundary spanning across the project life. Politician teams exhibit average levels of boundary spanning activity during requirements determination but much higher than average levels of boundary spanning activity during development. For example, during development all boundary spanning activities, but scout, are significantly higher than the over-all mean. However, there are no significant differences (from the sample means) for the politician's ISD performance.

Cluster 5 – Exhibitionists: Exhibitionist teams exhibit significantly higher-than-the-sample-mean levels of boundary spanning during both requirements determination and development. The exhibitionist's performance measures are mixed: labor productivity is significantly below the sample mean (meaning that these teams are the least efficient in the sample). However, the exhibitionist's stakeholder-rated team effectiveness after implementation is the highest of the sample and significantly higher than the sample mean. Values for the other three performance variables are very near the sample mean.

BOUNDARY SPANNING ACTIVITIES AND ISD TEAM PERFORMANCE

From this analysis we discuss two findings relative to our research question. First, none of the five patterns of social interactions identified had high levels of performance across all measures. Second, the pattern of relations among the variables does not support several commonly espoused relations about ISD teams.

The Varying Patterns of Boundary Spanning Interactions and Performance

Each of the five clusters exhibit differences in both their pattern of social interactions and the manner in which these patterns relate to the suite of ISD performance measures. For example, the exhibitionists (cluster five) perform a great deal of boundary spanning across the requirements determination and systems development. While they pay a price in terms of labor productivity, exhibitionists receive the highest ratings from stakeholders at implementation. In contrast, the isolationists (cluster two) perform relatively little boundary spanning during ISD but their performance is statistically equivalent to the sample mean. Isolationist teams have the highest labor productivity and their user satisfaction measures are among the lowest (though statistically undifferentiated from the sample mean).

These variations in performance indicate that the ways in which team members engage external constituents has performance implications. Greater cross-boundary engagement seems to reduce efficiency (the costs of labor productivity rises). The cluster with the highest overall ratings for user satisfaction – the politicians (cluster four) – engaged in higher levels of boundary spanning during development than did teams in the other clusters. This suggests that continuing and extensive boundary spanning interactions through development leads to more satisfied users. That is, even though it seems intuitive to "close" the team's boundaries during development, doing so may be counter-productively seen by users. This contrasts with the insulators (cluster three) who are near the sample means for boundary spanning interactions during requirements, but are significantly lower than the sample means for boundary spanning activity during development.

Evidence about borrower teams (cluster one) suggests a "coding" mentality drives them. That is, most of the high levels of boundary spanning activity are geared towards finding new things and coordinating resources, there is little control of information in and out of the team, and little attention to ambassadorial work. These teams are not very efficient (a common finding in ISD) and only moderately effective. However, borrower team members like their work.

Performance Variations

Findings indicate that a multi-faceted view of ISD outcomes provides a more robust picture than do any singular or aggregated measures. Moreover, the data suggest that it is not possible to simultaneously maximize all ISD performance indicators. For example, the correlations in Table 3 show there is little correlation between user satisfaction and labor productivity. The correlations in Table 3 also indicate there is a non-significant relationship between user satisfaction and labor productivity.

From Table 3 we note that stakeholder-ratings of ISD team effectiveness following both requirements determination and development are significantly and negatively correlated with post-implementation labor productivity. This suggests that there may be a trade-off between perceived project effectiveness and actual project cost (e.g., Glass, 1999). The absence of any cluster-level differences in stakeholder measures of requirements completion effectiveness (see Table 4) suggests that this performance measure may not be a good indicator of future performance. That is, what stakeholders perceive as a good start does not predict future performance levels of an ISD team in our sample.

Further inspection of Table 3 shows there is a significant positive correlation among stakeholder perceptions of ISD team effectiveness after requirements determination and the team's perceptual performance measures at implementation. However, post-implementation user satisfaction does not seem to be correlated to these three measures of ISD team performance. That is, the post-implementation success of the ISD team effort has no relation to interim perception measures of the team's effectiveness. This suggests that it may be problematic to predict post-implementation user satisfaction based on either internal and/or external measures of ISD team effectiveness.

Findings from the cluster analysis (see Table 4) provide little additional insight into this lack of a relationship between user satisfaction and other measures of team effectiveness. Perhaps the source of this missing link is a function of what is being measured? That is, it may be that users are assessing a system (or product) while the other measures used in this analysis measure aspects of the ISD effort (process) that are important to developers. This suggests that ISD efforts may not be as tightly linked to the ISD products as is commonly espoused. Evidence of this potential dichotomy has been discussed relative to packaged software development (Carmel and Sawyer, 1998). The possible implications of this process/product dichotomy in the more traditional custom ISD domain demands additional focused investigation.

Another concern with ISD performance measurement is that long-term measures of success may be indirect. For example, it may be that error reports are a proxy for use: more error reports indicate more use. However, most of the ISD teams (and their parent organizations) in this sample did not track error (bug) rates in a way that could be linked back to specific ISD projects. And, as an aside, only a subset of the organizations collected data on ISD labor costs at the team level (which is why this data is not reported for 20 of the 60 teams in the sample).

IMPLICATIONS AND ISSUES

In this paper we focus attention on identifying relations among five measures of ISD performance and 10 measures of the team's social activities. To do this, we developed a general model of ISD and characterized the social activities of developers as having external and internal components. In doing this we use a generic model of ISD and there is some concern that such a model may bias data collection towards traditional or waterfall methods. This suggests that future work on boundary spanning and performance in ISD should explicitly compare alternative approaches such as agile and other iterative methods.

We used cluster analysis to help us identify five patterns of boundary spanning interaction that ISD teams follow, each with its own set of relationships to multiple measures of ISD performance. The data were collected in the early 1990s and some may be concerned that tools and methods have progressed substantially since this time, making this data suspect. However, the social actions of developers, while clearly shaped in some part by the technologies being used, reflect social norms, behaviors and actions that are more stable over time. Clearly, however, more work is needed to assess the current level of software developer's social interactions to see if there has been change.

This analysis suggests that the relationships among social activity variables and performance measures are more complex than normative characterizations represented in the current literature suggest. These findings extend current theorizing on boundary spanning in ISD teams and provide additional insights into role of time in teams, as we discuss below.

Boundary Spanning in Information Systems Development Teams

Building on the work of Hansen (1999), we speculate that variations in the boundary-spanning activities of ISD teams may be related to the search and transfer of pertinent information. The underlying causes of the variations in social activities are not identified through this analysis. However, both Hansen's and Sole and Edmundson (2002) work highlight that knowledge transfer is a central part of NPD. The centrality of knowledge transfer among ISD teams has been observed for nearly 20 years (Crowston and Kammerer; 1998; Walz, et. al., 1993; Guinan, 1988). A focus on knowledge seeking and knowledge transfer seems likely to be one reason why social interactions are so central to these teams. One finding of this research is that differing approaches to social interactions leads to variations in ISD performance. This may be due to the level of success with searching and transferring knowledge across teams.

The Temporality of Social Interactions in ISD

Results of the analyses reported here provide additional support that social activities of ISD teams change over time (see also Walz, et al., 1993). For example, one stream of research on the temporal effects of group work is that of Gersick's model of punctuated equilibrium (1988, 1989; 1991). Gersick maintains that early in a work team's life (typically the first meeting) an initial direction for the team is established. As time progresses – typically at or near the "midpoint" of the group's life – this initial strategy proves to be inadequate and a crisis ensues. The midpoint crisis leads to a new direction which is expected to lead to the project's deliverables. A second crisis (at the final stage/last minutes of the project life) leads to overwhelming effort just prior to delivery. Gersick's field work showed that this pattern – inception, midpoint crisis, pre-delivery crisis – occurred in project groups whose work ranged from class projects to business decision-making and where the duration of these projects lasted from a few days to several months (Gersick, 1989).

Because the punctuated equilibrium model of group work is predicated on a fixed end-date, it is difficult to directly extend the reasoning of this temporal model of group work to ISD because most ISD efforts do not hold to a fixed end-date. A more common scenario in contemporary ISD is, as the midpoint crisis occurs, that the ISD team opts to move the end date. Such a reading of Gersick's work implies that an ISD project without a fixed end-date may fall into a pattern where each mid-point crisis leads to setting a new deadline. Then, half-way to this new deadline, another mid-point crisis ensues, leading to a new deadline, ... While anecdotal data on ISD supports this simple but disturbing analysis, an empirical assessment of the implications of moving end dates on ISD performance is needed.

Still, both our evidence, and the work of others, suggests that the work of ISD teams (like most work teams) changes over the life of a project (e.g., Walz, et. al., 1993). This suggests that work is needed to understand the patterns of variation across time and the relationships among these variations, the larger context in which these occur, and the impacts on performance. Newman and Robey (1992) and Robey and Newman (1996) have shown that contextual events, social activities and time are related, our findings suggest that there is a more complex set of events that link teams and their larger context.

The Complex Nature of ISD Performance

Findings from this study indicate that singular representations of ISD performance are an oversimplification. Data presented here show that better requirements-completion performance is not reflected in post-implementation user assessments. That is, we cannot substantiate the commonly held 'truism' that requirements are an instrumental predictor of ISD success. Further evidence of the complex nature of ISD performance is seen in the trade- offs among the boundary spanning interactions that differentiate these clusters of teams. For instance, the exhibitionist team's poor labor productivity and high user satisfaction ratings highlight how these team's additional efforts to support boundary spanning interactions might be affecting their performance.

These results provide insights for professional practice and also suggest opportunities for continued study. For example, studies of ISD with fixed deliverable schedules and with different measures of internal social activity will further add to our understanding of the performance impacts of differing patterns of social interactions. A better understanding of the patterns among the variables representing social activity should also provide insight on the potentially differential implications of development tools (such as integrated development environments), different methodologies such as object-oriented, or various iterative models of ISD. For example, iterative methods of design might encourage more boundary spanning activity across the ISD effort. Moreover, there may be benefits from ICT-based tools that support stakeholder access to view certain aspects of the ongoing development effort. Findings from this study suggest that simple or even singular models of ISD social activity, especially models that ignore the performance implications linked to variations in the ways team members work together and with stakeholders, cannot adequately represent the complexities involved in developing contemporary information systems.

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APPENDIX A: INDICATORS AND THEIR RELIABILITIES

This appendix contains the indicators used in this research. These are grouped by construct.

Social Activity Constructs

Please indicate the extent to which you currently see it as a responsibility to engage in the following activities with individuals outside your team. These outsiders may be in other companies or may be people in your company who are not formally assigned to the team.

Scale:							
Not At All	A Very Small Extent			To Some Extent			A Very Great Extent
0	1	2	3	4	5	6	7

Ambassador (alpha = .85 at requirements, .69 at implementation)

__ Persuade others to support the team's decisions.
__ Persuade others that the team's activities are important.

Scout (alpha = .83 at requirements, .88 at implementation)

__ Scan the environment inside or outside of the organization for project ideas or expertise.
__ Scan the environment inside or outside of the organization for technical ideas or expertise.

Coordinator (alpha = .87 at requirements, .84 at implementation)

__ Keep other groups in the company informed of your team's activities.
__ Coordinate activities with external groups.

Guard (alpha = .74 at requirements, .76 at implementation)

__ Avoid releasing information to others in the company to protect the team's image or product it is working on.
__ Keep news about the team secret from others in the company until the appropriate time.

Sentry (alpha = .80 at requirements, .85 at implementation)

__ Protect the team from outside interference.
__ Prevent outsiders from overloading the team with too much information or too many requests.

Performance Constructs

Scale: Very Poor Neutral Outstanding
1 2 3 4 5 6 7

Stakeholder-Rated Effectiveness at Requirements (alpha = .62)

In relation to other project teams you have observed, how would you rate this team on each of the following:

__ Ability to meet the goals of the project during requirements definition.
__ The team's reputation for work excellence during requirements definition.
__ The number of innovations or new ideas introduced by the design team.

Stakeholder-Rated Effectiveness, after Implementation (alpha = .77)

In relation to other project teams you have observed, how would you rate this team on each of the following:

__ The extent to which the system adds value to our firm.
__ The extent to which the system adheres to organization standards.
__ The extent to which the users' business needs are reflected in the system.
__ The contribution of the system to the performance of our firm.

Self-reported Effectiveness, after Implementation (alpha = .81)

In relation to other project teams you have observed, how would you rate this team on each of the following:

__ The extent to which the system adds value to our firm.
__ The extent to which the system adheres to organization standards.
__ The extent to which the users' business needs are reflected in the system.
__ The contribution of the system to the performance of our firm.

User Satisfaction (3-6 months after implementation) (alpha = .96)

Scale: N/A Strongly Neither agree Strongly
Disagree nor disagree Agree
0 1 2 3 4 5 6 7

Please provide your impressions of how the present system satisfies your needs.

__ The system provides the precise information that I need.
__ The information content meets my needs.
__ The system provides reports that seem to be just about exactly what I need.
__ The system provides sufficient information.
__ I find the output relevant.
__ The system is accurate.
__ I am satisfied with the accuracy of the system.

__ The output is reliable.
__ The system is dependable.
__ The output is presented in a useful format.
__ The information is clear.
__ I am happy with the layout of the output.
__ The output is easy to understand.
__ The system is user-friendly.
__ The system is easy to use.
__ The system is efficient.
__ I get the information I need in time.
__ The system provides up-to-date information.

Table 1: Data Collection

Survey Target	Time	Form	Variables	N (indvl)	Indvl/team	# Teams
Developers	Rqrmnts	Mail	Process	252	4.2	60
Stakeholders	Rqrmnts	Phone	Performance	92	1.48	52
Developers	Implmnt	Mail	Process	210	3.5	60
Stakeholders	Implmnt	Phone	Performance	90	1.5	47
Info. System	Post Imp.	See note	Performance	N/A	N/A	40
End Users	Post Imp.	Mail	Performance	122	2.71	45

Note: Function points for each IS were counted by members of the research team. A phone survey with the IS project leader was used to collect project and labor cost data.

Table 2: Variable Means and Standard Deviations

Variable	Time	N	Mean	Std. Dev.
Ambassador	Requirements	60	4.22	1.12
Scout	Requirements	60	4.02	0.82
Coordinator	Requirements	60	4.03	1.21
Sentry	Requirements	60	2.98	1.08
Guard	Requirements	60	2.08	0.95
Ambassador	Implementation	60	4.01	1.29
Scout	Implementation	60	4.11	1.29
Coordinator	Implementation	60	4.36	1.33
Sentry	Implementation	60	3.53	1.48
Guard	Implementation	60	2.37	1.27
Stakeholder-rated Effect.	Requirements	52	5.23	0.84
Team-rated Effectiveness	Implementation	60	5.08	0.94
Stakeholder-rated Effect.	Implementation	47	5.49	0.75
Labor Productivity	Post-Implement.	40	3.42	1.50
User Satisfaction	Post-Implement.	45	5.39	1.02

Table 3: Correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Process Measures																
At Requirements																
1 Ambassador	1.00															
2 Scout	.63*	1.00														
3 Coordinator	.76*	.56*	1.00													
4 Guard	.30*	.26*	.01	1.00												
5 Sentry	.78*	.43*	.64*	.34*	1.00											
At Implementation																
6 Ambassador	.33*	.21	.27*	-.07	.18	1.00										
7 Scout	.32*	.29*	.34*	.06	.22	.41*	1.00									
8 Coordinator		.30*	.29*	.40*	-.09	-.03	.70*	.60*	1.00							
9 Guard	.01	-.05	-.05	.08	.05	.44*	-.03	.17	1.00							
10 Sentry	.12	.11	.12	-.01	.11	.63*	.43*	.54*	.49*	1.00						
11 Cohesion	-.20	-.28	-.11	-.13	-.11	.07	.06	.07	.15	.02	1.00					
Performance Measures																
At Requirements																
12 SR-Effectiveness	.19	-.05	.19	-.25	.12	.13	.25	.07	-.07	-.11	.31*	1.00				
At Implementation																
13 TR-Effectiveness	.23	.11	.20	-.14	.09	.08	.18	.06	-.15	-.16	-.01	.47*	1.00			
14 SR-Effectiveness	.10	.08	.05	-.10	.10	.06	.10	.03	-.17	-.16	.16	.38*	.18	1.00		
Post-Implementation																
15 Labor/Productivity	-.30*	-.28*	-.33*	.01	-.31*	-.15	-.31*	-.38*	.04	-.08	.22	-.34*	-.15	-.38*	1.00	
16 User Satisfaction	-.08	.01	.03	-.03	-.06	-.17	.03	-.18	.18	-.14	.36*	.04	.29	.14	.05	1.00

Where "*" means $p < .05$, SR means stakeholder-reported, TR means team-reported

Table 4: Cluster Analysis across Social Activity Variables[1]

Cluster / Variable	Cluster 1 (n=16)	Cluster 2 (n=14)	Cluster 3 (n=10)	Cluster 4 (n=15)	Cluster 5 (n= 5)	Mean (Std. Dev)
Requirements:						
Ambassador	4.34	**2.84** ***	4.2	4.08	**5.63 *** **	4.22 (1.12)
Scout	**4.22****	**3.23 *** **	3.68	3.85	**4.74 ****	4.02 (0.82)
Coordinator	4.55	**2.76 *** **	3.79	4.05	**5.32 *** **	4.03 (1.21)
Sentry	2.96	**2.08 *** **	3	2.9	**4.71 *** **	2.98 (1.08)
Guard	1.59	1.71	2.3	1.64	**2.98 ***	2.08 (0.95)
Implementation:						
Ambassador	4.25	**2.79 ***	**3.43 *** **	**5.23 ****	**5.24 *** **	4.01 (1.29)
Scout	**4.84 ****	**3.49 ***	**2.82 *** **	4.5	**6.00 *** **	4.11 (1.29)
Coordinator	**5.26**	**2.90 *** **	**2.98 *** **	**5.34 *** **	**5.16 ****	4.36 (1.33)
Sentry	**3.13 ***	**2.80 ***	**2.65 *** **	**5.35 *** **	**5.37 ****	3.53 (1.48)
Guard	**1.39**	2.01	**2.28 ****	**3.78 ****	2.30 #	2.37 (1.27)
Performance:						
Stakeholder-Rated Effectiveness (Req.)	5.34	5.15	5.19	5.12	5.33	5.23 (0.84)
Stakeholder-Rated Effectiveness (Imp.)	5.5	5.44	5.32	5.5	**6.04 ****	5.49 (0.76)
Team-Rated Effectiveness. (Imp.)	5.38	5.08	4.91	4.89	4.99	5.08 (0.94)
Labor Productivity (Post-Imp.)[2]	**2.74 ***	3.99	**4.51 ***	3.26	**1.87 ***	3.42 (1.50)
User Satisfaction (Post-Imp.)	5.13	5.72 #	5.35	5.58	5.13	5.39(1.02)
Name given	**Borrowers**	**Isolationists**	**Insulators**	**Politicians**	**Exhibitionists**	

Where $p < .10$ = #, $p < .05$ = *, $p < .01$ = ** and $p < .001$ = ***

Notes:

1. All responses based on seven-point Likert-like scales where higher numbers are rated as more or better.
2. Labor productivity is scaled. Higher numbers indicate more function points developed per unit cost (higher levels of labor productivity).

Figure 1: Research Model and Data Collection Time-Line