THE EFFECT OF SOCIAL FACTORS ON PROJECT SUCCESS WITHIN ENTERPRISE-CLASS SYSTEM DEVELOPMENT

By

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ABSTRACT

Over time enterprises have woven together a fabric of processes, information structures, and computer tools to conduct their day-to-day business. Many of the components of this patchwork of systems cannot work together effectively, as the underlying models are incompatible. There is however, a strong business case to be made for ensuring that end-to-end business processes are interoperable, both across the enterprise, and with other enterprises. Qualitative research demonstrates that distinct cultures and non-overlapping knowledge between IS development (ISD) team members impedes system development success. It also identifies Boundary Spanning mechanisms as a significant mitigator. We develop these ideas further by exploring the mechanisms of knowledge sharing in project teams covering overlapping competence, and the presence of knowledge integration mechanisms - acculturation, boundary spanning roles- in how they affect ISD success. We utilize survey data derived from 139 ISD projects in a global US automotive OEM, completed between 2006 and 2009. We show that boundary spanning roles, acculturative processes, and cross-domain knowledge affect in significant ways IS development success. In particular, we demonstrate that facilitative boundary spanning roles - ambassador, coordinator, and scout - moderate the relationship between accumulated IS business domain knowledge and ISD success, and that IS business competence is partially determined by acculturation among IS team members, and the technical competence of the IS team. Teams with low levels of business domain knowledge may be able to mitigate their business knowledge deficit by engaging in boundary spanning behaviors as to enhance the flow of information across the team's knowledge boundaries.

Keywords: Acculturation; Boundary Spanning; Business Process; Competence; Confirmatory Factor Analysis; Culture; Enterprise Information Systems; Exploratory Factor Analysis; Information System Development; Interoperability; Mindset; Path Analysis; Project Success; Quantitative; Social Construction; Structural Equation Modeling

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INTRODUCTION TO THE THREE STUDIES THAT COMPRISE THE RESEARCH REQUIREMENTS FOR THE DOCTOR OF MANAGEMENT PROGRAM

Over time, enterprises have woven together a fabric of processes, information structures, and computer tools to conduct their day-to-day business. Many components of this patchwork of systems cannot work together effectively, as the underlying models and technologies are incompatible. There are growing demands and a strong business case to reduce cost and speed up business by creating interoperable end-to-end business processes across the enterprise and with other enterprises. Re-structuring and inter-firm collaboration form two key strategies to improve firm's competitive positions. However, both measures require interoperable enterprise systems that allow processes and connections to be configured rapidly to support the change in business (Kim, Lee, Kim, & Kim, 2006; Anaya & Ortiz, 2005).

There is a great deal of work on how to technically achieve interoperability across business, including architectural frameworks (Braun & Winter, 2007), and systematic approaches to govern the enterprise (Hussain & Siddiqui, 2005; Heier, Borgman, & Maistry, 2007). The two key thrusts of this literature are sponsorship by senior leadership, and the use of governance frameworks that provide consistent approaches to building systems and processes. Anecdotal evidence suggests, however, that less progress has been made in achieving smooth business integration than what these works suggest. This research addresses this gap by generating a grounded theory of a set of impediments that thwart business and IS personnel to develop solutions that meet business needs. In particular, my aim is to shed light on the causes of IS-business "alignment" failure, and to propose factors

that affect the effectiveness of IS development team interactions, as it defines processes, information structures, and computer tools that support business processes.

The research program consists of three studies where each uses a distinct inquiry. The first study, "Culture clash - how socio-technical factors contribute to enterprise information systems interoperability" engages in a conceptual inquiry to three sociological theories that deal with knowledge transfer and learning in social settings. The study leverages upon the researcher's experience from problems of practice and creates a conceptual model and related research questions, which serve as the foundation for the qualitative and quantitative study.

The key question formulated in the study is: "What social factors influence the development of shared understanding in teams that contribute to developing interoperable systems?" In particular we ask: how and to what extent do boundary spanning roles, acculturation, mindset, and socio-technical construction influence team shared understanding? Of particular interest were the impediments to developing the shared understanding that has been reported to be critical to project success (Reich & Benbasat, 2000). We posit that acculturation and boundary spanning strongly influence the flow of knowledge between the IS and business personnel. We further argue that as teams set goals for the development projects that the sort of mindset they adopt: conservative vs. radical can impact success. More conservative teams might not move fast or far enough, and lose management support. Conversely more radical teams might overstretch themselves and thus fail completely. Finally we suggest that development goals themselves, once developed, are social constructions and often based on incomplete organizational cultural understanding and thus result in inappropriate process, or outcome.

This served as the point of departure for the qualitative, field-work-based research study that involved interviews with 18 practitioners and followed a semi-structured interview protocol. The study validated the impact of some factors in the initial conceptual model. In particular, it highlighted difficulties teams composed of members coming from different functional areas and cultures face while participating in IS development. The crucial role of experienced boundary spanners in both IS and business functions in mitigating these difficulties through their capability to orchestrate cross-domain knowledge flows was the key finding.

The third study, "The Mechanisms and Effects of Boundary Spanning for Enterprise-Class System Development Project Success", investigates the influence of boundary spanning roles, acculturation, and cross-functional competence on project success. I applying survey data and use causal modeling to detect the impact of these antecedents for project success defined in terms of system quality, satisfaction with system use, and satisfaction with the development process. Overall, our findings are novel in that they show that these boundary spanning mechanisms are critical to successful development. The purpose, methods and conclusions of each of the three studies are presented below in greater detail. This paper concludes with some observations about the collective implications of these three research studies for practitioners and notes limitations and future research avenues.

PURPOSE, METHODS AND CONCLUSIONS OF EACH STUDY

The Conceptual Study: "Culture Clash - How Socio-Technical Factors Contribute to Enterprise Information Systems Interoperability"

With the overarching purpose of understanding how social factors contribute to the success of information systems to support business processes; the goals of this study were:

1) to underscore the problem of practice and its relevance to organizational transformation; 2) to establish a framework that draws on existing literature in the field of teamwork effectiveness; and 3) to develop the research questions for the subsequent studies. The merit of understanding these factors is that it improves practitioner's understanding how to improve the business impact of system development.

The technical body of knowledge that describes how to ensure that processes, information models, and computer tools work together is well established (Vernadat, 2007). In contrast, this research focuses on social factors that affect knowledge sharing within development teams as gaps in sharing knowledge have been observed to impede systems development with significant negative business impact. Acculturation and Boundary Spanning theory, (Berry, 1979; Kottak, 2005; Miller-Loessi & Parker, 2006; Soaries, 2003) was chosen to articulate mechanisms and effects of knowledge interchanges between business and IS groups on system development success. The creation of language and customs across these domains can be conceived through the process of social construction (Pinch & Bijker, 1984).

To operationalize this concept we outlined a model with indepent variables of Acculturation, Mindset, and Social Construction, and a dependent variable of Group Understanding. These relationships are moderated by Boundary Spanning roles.

The Qualitative Study: "Culture Clash - How Socio-Technical Factors Contribute to Enterprise Information Systems Interoperability"

The influence of different cultures of business and IS on each other is analyzed through the lens of acculturative processes that mediate understandings between the groups. Kottak (2005) defines acculturation as the exchange of cultural features when groups come

into continuous contact with each other where the cultural patterns of either or both groups are altered, while the groups remain distinct. Social Construction posits that social constructs are artifacts of a particular community of practice, created through an on-going process of sense-making. For example, Pinch and Bijker (1984) demonstrated that people came to a common understanding of technological artifacts, such as what is a "bike", through a process of sense-making and negotiation.

In this study we were particularly interested in the impact of mindset on setting and pursuing goals. Gollwitzer & Moskowitz (1996) describes this impact, by noting that the stages of pursuit are more effectively traversed when an appropriate mindset is adopted. The pursuit stages are categorized as goal setting (pre-decisional), implementation (pre-actional), and post-actional. A deliberative mindset is conducive to goal setting, and an implemental mindset is conducive to implementation.

This study sought to advance understanding about how a development team's Understanding of Business Process, Information, and Tool Integration of the Enterprise are influenced by business function knowledge, the mindset of the people in those functions, and the social construction that is used to express understanding of the system and how this influence might be influenced by business/IS boundary spanners.

Five senior and thirteen middle managers of a single automotive OEM, located in the Midwestern region of the United States, participated in the study. Respondents included both information technology practitioners and their counterparts from a variety of business activities. Drawing participants from a single company permitted a broader grouping of business functions to assess differences between highly technical ones such as engineering, and more commercially oriented groups such as purchasing and finance. It also provided the

opportunity to hear versions of the same situation from multiple perspectives as to better understand how meanings are developed and attributed to experience.

In all cases the interviewees were involved with the subject domain of Bill of Material, and had at least four years of in-depth experience. Each interview lasted 60 to 90 minutes and was conducted in a setting that assured privacy. Digital audio recordings of the interviews ensured accuracy of note capture and the transcribed notes were imported into Qualrus software to facilitate the coding of the data for further thematic analysis.

The conceptual study raised our expectations that the different cultures of the business groups, mindset, social construction, and boundary spanning would have a direct impact on the shared understanding of teams. The qualitative research supported these notions, and further reinforced that the concept of each culture speaking their own language was a key aspect that promoted a lack of understanding (Basso, 1967). We had also expected that boundary spanning evidenced by IS members becoming competent in the business domain would be significant, which was supported. The research also demonstrated the converse: that business people becoming competent in IS was also a significant contributing factor.

Our research suggested that the union of dissimilar functional groups in cross-functional teams challenges the development of successful enterprise systems; however the knowledge sharing maybe facilitated by boundary spanners who promote the creation of shared meanings. Our findings contrast with technical enterprise systems literature, which has focused primarily on technological factors to ensure successful design and implementation. We argue that the failure to create successful solutions when focused solely on technological approaches leaves room to consider other factors that account for some of

the observed problems. Our work highlights social factors as a major contributor to effective development practices. The research was conducted at a technologically sophisticated company, yet good interoperability between systems was not being achieved consistently.

The Quantitative Study: "The Mechanisms and Effects of Boundary Spanning for Enterprise-Class System Development Project Success"

In the quantitative study I sought to explain in greater depth the factors and combinations of factors that can contribute to project success. To that end my causal model examined the mechanisms and effects of boundary spanning on ISD success. The concept that boundary spanning exists as both a set of competence factors that share knowledge and experience across the domains of IS and the business, and as an integrative set of factors that manage knowledge flows across organizational boundaries is a central part of the causal model.

Developing enterprise-class Information Systems (IS) is a complex undertaking that relies heavily on cross-functional teams (Cheney & Lyons, 1980). These teams, often with a global reach, comprise business people, usually from multiple functional units, working together with IS personnel. The teams by design do not have members with completely overlapping knowledge sets (Maruping, Venkatesh, & Agarwal, 2009). Furthermore, members come from different organizational backgrounds with distinct cultures, which tend to thicken the knowledge boundaries (Orlikowski, 2002). Developing a shared understanding of the needs of the business and an associated IS solution by relying on the disparate knowledge sets is, however, critical for information system development (ISD) project success (Reich & Benbasat, 2000).

A good deal of information systems research has concentrated on how distributed cross-disciplinary IS teams can carry out successful ISD projects (Blanton, Schambach, & Trimmer, 1998). They suggest that paying attention to communication and knowledge coordination within development teams in ways that span knowledge boundaries affects project success. This boundary spanning can take four primary forms: (1) active boundary spanning roles (Sawyer, Cooprider, & Guinan, 2008); (2) IS competence of businesspeople (Bassellier, Benbasat, & Reich, 2003); (3) business competence of IS people (Bassellier & Benbasat, 2004); and (4) acculturation of IS people into the ISD domain context (Korzenny & Abravanel, 1998). While previous research has addressed many of these boundary spanning practices separately and their effects on aspects of a project engagement, none have addressed the relationship between the different modes of boundary spanning, nor the impact of boundary spanning practices and competencies directly on project success (Espinosa, DeLone, & Lee, 2006).

To assess the effect of the different modes of boundary spanning on project success, we developed a model in which we posited relationships between the different modes of boundary spanning and different elements of project success. To validate the model, we conducted 399 surveys of project members and managers across 154 enterprise-level ISD projects at a large North American automotive OEM. Our findings indicate that boundary spanning mechanisms included not only boundary spanning role behaviors recognized by Ancona and Caldwell (1991), but also acculturative processes of building business and IS domain knowledge during everyday encounters. Moreover, cross-domain knowledge and related experience acquisition form significant factors affecting IS development success. We also found that IS business competence and IS technical competence influence directly

project success. We further showed that IS business competence was determined by the level of acculturation with their business partners among IS members in teams, and the technical competence of the IS team. Finally we demonstrated that facilitative boundary spanning roles: ambassador, coordinator, and scout, moderate positively the relationship of the accumulated IS business domain knowledge on project success. In practice, this implies that development teams with low levels of domain knowledge among IS members of the team can mitigate this deficit by exhibiting stronger facilitative boundary spanning role behaviors.

RESEARCH IMPLICATIONS

Implications for the Practitioner

The implications for practice are significant. They can be applied at all phases of the project life-cycle. We will enumerate them therefore in a chronological order. We have demonstrated significant relationships between IS business competence and project success - in particular when the level of boundary spanning is low. Our primary implication for IS practicing managers is to ensure that they build and maintain a steady supply of IS professionals that are well versed in business knowledge. We also noted that when boundary spanning is high, the level of business knowledge among the IS staff is less critical. This provides a second opportunity for IS managers: if IS professionals are not familiar with the business domain, then one should staff the team with members who are skilled in boundary spanning, so as to ensure that the requisite business knowledge can flow across the boundaries.

A second set of implications arise during the development process. Typical project management processes measure in-cycle project execution metrics, such as resource usage, meeting work product delivery dates, etc. to identify areas of risk. These are then addressed

by a set of mitigating actions, as to keep the project under control. Few project management techniques in the world of practice focus on measuring social factors associated with the project (Wallace, Keil, & Rai, 2004), and yet our research demonstrates that these explain the greatest amount of variance in project success (Jiang, Klein, & Pick, 2003). We recommend that project managers maintain in-process metrics that examine team knowledge and business competencies, and adjust these skills as necessary throughout the project execution. This might take the form of training sessions, interventions with business experts, use of techniques that improve knowledge sharing etc.

The final set of implications address the overall quality of the business relationships between IS and their business partners. Ongoing contacts between the IS practitioners and business representatives are essential to develop high levels of business knowledge. Outsourcing or off-shoring can be particularly detrimental, as can high degrees of centralization of IS development. We recommend that IS managers evaluate which aspects of their development processes are vulnerable to the lack of critical business knowledge, and find appropriate counter-measures.

Implications for Academic Research

Overall, our findings contribute to the literature in several ways. We extend theorizing about the role of IS business competence and its impact on project success. Prior research had included more limited measures of acculturation with IS business competence. We are now able to break these apart, and understand at more detailed level how acculturation drives the development of business competence. We have further posited that IS technical competence plays a role in providing the IS practitioner with relevant skills to acquire this knowledge. Again, prior research has studied the role of IS business competence

with regard to intentions of the business community to further engage their IS counterparts, but it has not to our knowledge been identified as a significant antecedent for project success. Another strength of this research is the large sample of teams, which enabled us to test a more comprehensive model of social factors affecting ISD success.

Limitations

There are limitations specific to the qualitative study. The study focused on the development of Bill of Material systems in a single automotive manufacturer in the US Midwest. As a result some aspects of this study may only be relevant to this particular manufacturer. The upside of this approach is that the range of business functions permits control for those functions, while still including sufficient people for comprehensive discussion of inhibiting and assisting factors. The collection of data from each of the business functions relied on interviewee's recollection of events. We acknowledge that the effect of time may have biased findings. Results may also have been affected because the interviewer was known to some of the people interviewed, and had interacted with them in the past. As is common with an interpretative approach, the categorization and analysis of data depends heavily on the perspectives and understanding of the researcher. Peer coding of the data was used to limit researcher bias and assure independence of categorizations

We also recognize limitations in our measurement of satisfaction with system use as users were not part of the sample and their satisfaction level was reported through a third party: the IS team members, and the business and IS sponsors. We also recognize that the satisfaction with new capabilities is difficult to assess, as changes in the software, and user satisfaction over time is best captured through a longitudinal study. We examined archival data on satisfaction held by the automotive OEM, but it was not sufficient to permit an

independent assessment of the reported values. A further limitation to this work is that the data was collected from only a single enterprise. The decision to do this was made as we had an access to large number of software development teams and the desire to control for as many elements as possible to minimize the potential for confounding effects.

Future Research

As mentioned, future research should seek to replicate this work in a number of environments to generalize the results. Governmental, Non-Profit, and Commercial sectors, together with an expansion of the Industrial sector outside of Automotive would provide further validation. Expansion of the subjects interviewed to include direct users could provide further insight into the impact of the antecedents on organizational impact, as well as provide further insight into their impact on individual impact.

We also believe that further work is required in understanding the role of the acculturation processes on competence creation. Qualitative research (Fisk, 2009) suggests that competence is built over a period of several years. Yet, a better understanding is needed of how this is effectively built, and deployed both during development projects, and in regular contacts between IS and their business partners. We did not distinguish specific IS roles during the research. Therefore further work is needed to identify which specific roles are most sensitive to business knowledge. One might assume that business analysts and designers are the most critical roles, and that programmers are less so, if enough business knowledge is captured in the requirements documents. However, as much of the business knowledge is tacit, and organizations engage in agile processes which blur the roles of different IS specialists. Therefore, further studies are warranted.

Our research focused on the influence of social factors on the elements of project success. We did not build a complete model of the project success factors, although we broadly noted DeLone and McLean's (2003) position. We believe that a further step that might be taken with the data collected is to further refine the relationships within that multi-dimensional construct.

One further area of research is to identify further factors that explain system quality when boundary spanning is high. In this case the social factors accounted for only about a third of the variance. We hypothesize that the direct contribution of business domain knowledge within the team accounts for that, but other factors should be assessed as well.

CONCLUSION

These three studies have made important contributions to theory and practice. We have been able to explain how acculturation and IS technical competence influence the creation of IS business competence, which we have further identified as a significant antecedent for project success. A further strength of this research is the large sample of teams, which enabled us to test a more comprehensive set of knowledge based social factors affecting ISD success, in particular the multiple roles of boundary spanning.

From the perspective of practicing IS managers, we have made a number of significant suggestions. Noting the influence of IS business competence and boundary spanning we recommend that IS managers maintain a steady supply of IS personnel well versed in the knowledge of the business domain, and that failing that they create appropriate boundary spanning roles to facilitate the flow of business domain knowledge across organizational boundaries during project execution. We further suggest that relationships

with business counterparts are strengthened, and that project management processes are improved to recognize the role that social factors play in development projects.

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Note to the reader: Each of the three research reports was created as a stand-alone document per specific Case Western Reserve University Weatherhead School of Management Executive Doctor of Management publication guidelines. Two separate submittals were made and accepted by the Academy of Management (Summer 2008 and Summer 2009). As such, there is a certain degree of content as necessary background repeated in the opening sections of each study.

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CULTURE CLASH - HOW SOCIO-TECHNICAL FACTORS CONTRIBUTE TO ENTERPRISE INFORMATION SYSTEMS INTEROPERABILITY

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ABSTRACT

Over time enterprises have woven together a fabric of processes, information structures, and computer tools to conduct their day-to-day business. Many of the components of this patchwork of systems cannot work together effectively, as the underlying models they are based on are incompatible. There is however, a strong financial case to be made for ensuring that end-to-end business processes are interoperable, both across the enterprise, and with other enterprises. There is a great deal of theory to describe how to achieve Interoperability from a technical perspective, and a growing body of theory that describes systematic approaches to govern this domain. Theory aside, the world of practice continues to demonstrate little forward progress. . This paper will seek to address this apparent gap between what is promised and what is realized. Proposed qualitative research is motivated by the notion that acculturation issues between the business community and its IT counterparts play a significant role in sub-optimizing integration capabilities.

PREFACE

The reality of the world of practice today is that non-interoperable computer systems cause extensive non-value added costs, time delays, and quality problems both within and across enterprises. While theory tells us how to achieve better results, as a professional body, Information Technologists continue to deliver less than optimal results. My inquiry is motivated by curiosity as to the causes of this failure, and a deep desire to contribute to its resolution.

There is sufficient theory to be able to define, develop, and implement fully interoperable information systems, yet in practice this is seldom achieved. My observation of the world of practice suggests that when people with many years of combined business and IT experience are able to work with teams to guide enterprise level developments, a more fruitful relationship between IT and their business partners seems to result from this boundary spanning. The information systems are better structured and work more effectively across the enterprise.

In my own experience, there appears to be a communication challenge, which is the result of cultural differences between IT and the business people they interact with. The business people are experts in their own domain, but they struggle to be effective as they work together. There is seemingly a lack of common language, customs, and other attributes that are components of a culture.

Again, from my own observations, I have also seen teams define information structures that work perfectly in their own domains, but do not work well across the enterprise. What causes people to accept a less than complete solution? I believe that people limit the implementation to meet other unstated goals, and so redefine success in a way that

allows for this narrowed vision. This research will also look for explanations rooted in the mindsets of the team members, as well the processes of social construction by which teams come to accept a common definition of success.

INTRODUCTION

Over time, enterprises have woven together a fabric of processes, information structures, and computer tools to conduct their day-to-day business. Many of the components of this patchwork of systems cannot work together effectively, as the underlying models on which they are based are incompatible (Kim, Lee, Kim, & Kim, 2006). The authors point to the proprietary architectures that have been developed within value chains that previously had no need to interoperate outside of their own closed domain. They cite the growing demands to reduce cost and speed up business as the key driver. This theme is expressed by Anaya and Ortiz (2005), who make a strong financial case to for ensuring that end-to-end business processes are interoperable, both across the enterprise, and with other enterprises. They cite restructuring and collaboration as two key strategies that companies use to improve their competitive position. Both strategies require interoperable enterprise systems that allow new processes and connections to be configured rapidly to support the changing business models; without these companies will fail to respond to competitive challenges in a timely manner.

Definitions are useful at this point. *Interoperability* is the capability for systems to work together (broadly speaking, interoperability is the ability to perform a process between two or more entities). Vernadat (2007) defines the scope of interoperability to be: Business Processes, IT Applications, and Human Resources. A similar but subtly different concept is *Integration* which is the capability for systems to talk to each other. The latter is a pre-

requisite for the former. He states that integration requires a coherent Information Systems (IS) architecture that links Business Process, Information Stores, and Systems, so that they appear seamless to a user. *Architecture* is defined as the organization of the components of a socio-technical system and their relationships to the environment, as well as to themselves. The architecture also contains the design rules for developing and structuring the system.

There is a great deal of technical theory to describe how to achieve *Interoperability*, described by Vernadat (2007) as the capability of information systems to work together. Architectural frameworks provide consistent definitions of Business, Process, Application, Software, and Technology to ensure that all aspects of the design are covered (Braun & Winter, 2007).

There is also a growing body of theory that describes systematic approaches to govern this domain (Hussain & Siddiqui, 2005; Heier, Borgman, & Maistry, 2007). The two key thrusts of this literature are sponsorship by senior leadership of the enterprise, and use of governance frameworks that provide consistent approaches.

Anecdotal evidence from the world of practice suggests less progress than these theories indicate. This research proposed in this paper aims to investigate this apparent gap between what is promised and what is realized. In particular, this research seeks to generate a grounded theory about social issues between business people and their IT colleagues.

The aim is to shed light on the root causes of interoperability failure, and to propose theory that will contribute to approaches to information management for the teams that define and maintain the processes, information structures, and computer tools that comprise these information systems.

The initial locus of the research will follow the anecdotal evidence. Three broad social concepts will be explored to sensitize the discovery process of the qualitative research: *Acculturation*, *Social Construction of Technology*, and *Mindset*. Acculturation is the exchange of cultural features that results when groups come into continuous firsthand contact; the original cultural patterns of either or both groups may be altered, but the groups remain distinct Kottak (2007). Social Constructionism suggests that social constructs are artifacts of a particular culture, created through an on-going process of human choice, this theory was first proposed by Berger in 1966 (Perdue, 1986), and was applied to technology by Pinch and Bijker (1984). Mindset theory describes a pre-existing cognitive bias that creates a powerful incentive to accept prior action choices. In particular, the work of Gollwitzer and others on goal effect on action and cognition seems to be germane.

Acculturation theory can be used to explain a number of less than optimal interactions between cultural groups, such as the IT and other business groups. The strongest indicator of culture change is language (Basso, 1967) and further evidence of transformation is seen in the stress that is required to trigger change (Kim, 2006).

Social Construction of Technology can shed light on the processes used by teams to define and approve project goals and approaches. Information and process models are created to define how and when groups interact; we need to better understand how the project teams, and other stakeholders come to a conclusion that particular models do indeed represent the real world sufficiently well to be useful (Anaya & Ortiz, 2005; Braun & Winter, 2007; Emmerich, Ellmer, & Fieglein, 2001; Goethals, Vandenbulcke, & Lemahieu, 2004).

People have selective interests (reflected by their needs, motives, and goals), either transient or long term, that help to shape their construal of their social world (Gollwitzer &

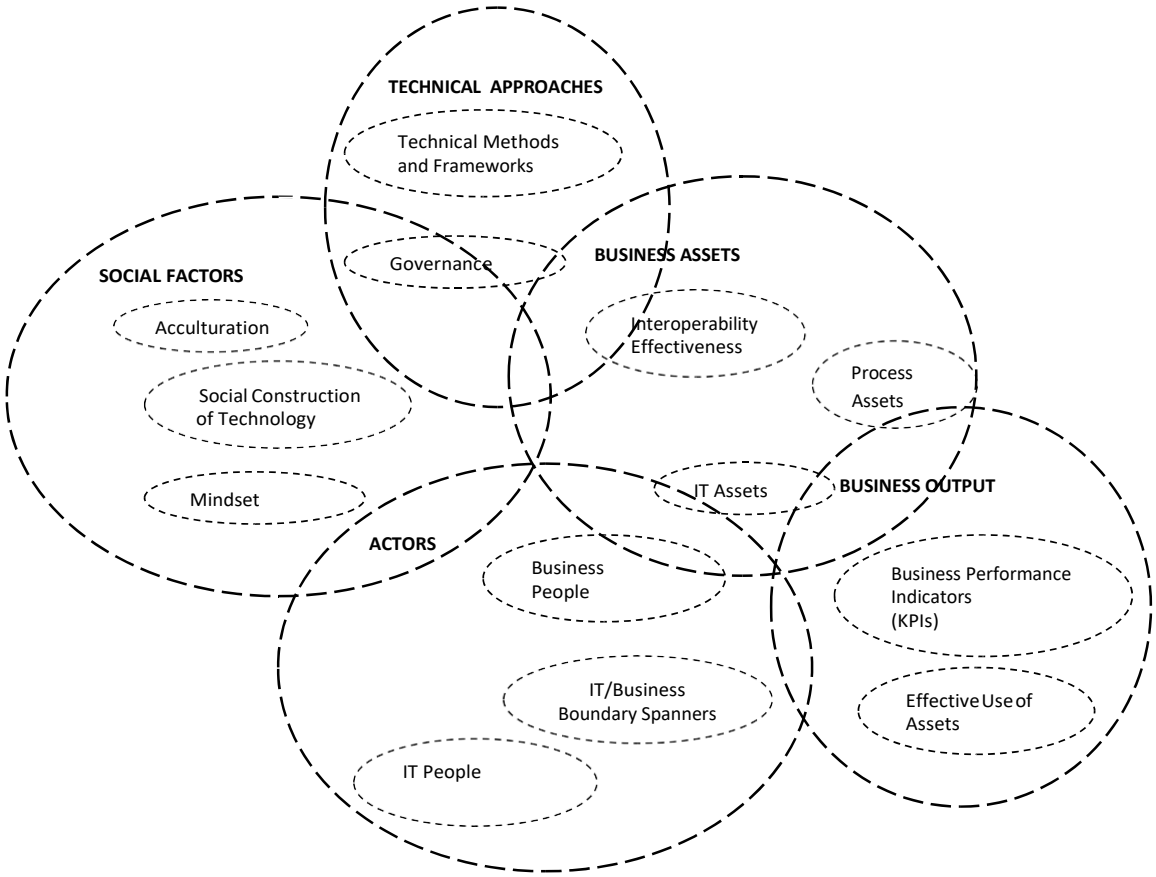
Moskowitz, 1996). When project teams come together to develop a new capability for the enterprise their pre-existing biases which will to some extent be expected to impact the final implementation. This research will attempt to discover if these biases, social constructions, and culture differences are responsible for any or all of the failings of project teams to implement fully interoperable solutions.

RESEARCH QUESTION AND CONCEPTUAL MODEL

The research question is: How do social factors contribute to the success of enterprise processes and the ability of their respective information systems to work together?

The context of the research is shown in Figure 1 Situational Map, which depicts the relationship between the key elements of the Business; the people (Actors), and the assets, and the ways that the people work together (Social Factors) and with the assets (Technical Approaches).

FIGURE 1
Situational Map



The Output of the Business is driven by the Actors, specifically the Business People, using the Assets owned by the Business, which include the Processes, the IT Tools, or information systems, and the capability for these to work together to support the endeavors of the enterprise. The actors are the business people from all the usual enterprise functions, Engineering, Manufacturing, Finance, Purchasing, Logistics, etc., their IT counterparts, and the IT/Business Boundary Spanners, those people from both IT groups with extensive business experience, or from business groups who typically oversee IT developments in their activities, and usually have extensive IT experience. The actors engage in the development

and maintenance of the business assets, using methods and frameworks to ensure consistency, and governance models that ensure representation of the varied business groups and IT. The effectiveness of the asset development and maintenance is the focus of the research, specifically the social factors that might explain any less than expected effectiveness. The unit of analysis for this research will therefore be at the actor level, looking at the interchanges between actors, noting the roles each individual plays, their behaviors, and the impacts on others during those interchanges.

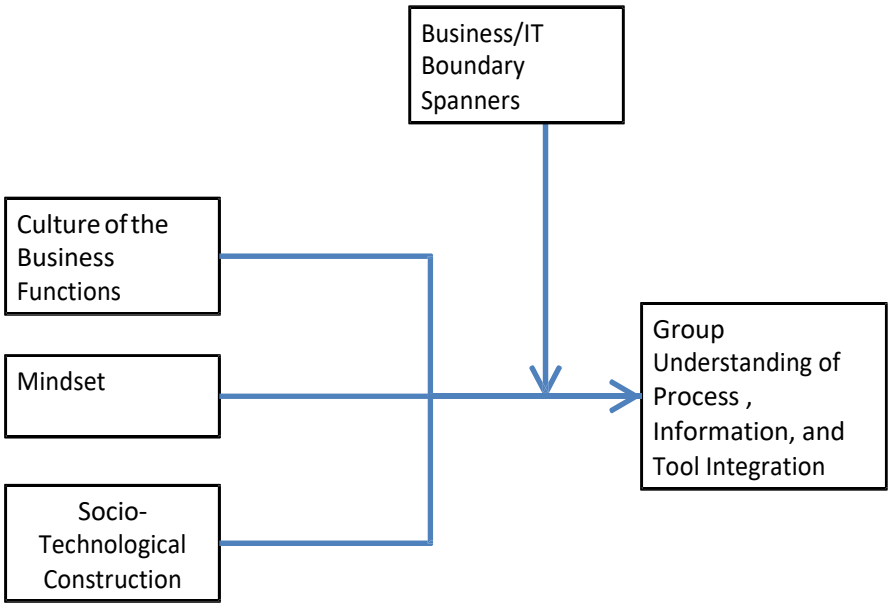
The body of knowledge that describes technically how to ensure that processes, information models, and computer tools can work together is well established (Vernadat, 2007). This covers both the design aspects of the processes and information systems (Ram, 1995; Goethals, Lemahieu, Snoeck, & Vandenbulcke, 2007), as well as the design of the operating methods for their development and implementation (Pereira & Sousa, 2004). There is also a growing body of knowledge that describes how to govern these developments effectively, over time (Simonsson & Ekstedt, 2006; Heier et al., 2007; Hussain & Siddiqui, 2005).

There is sufficient theory then, (which be more fully dealt with in the literature review) to be able to technically define, develop, and implement fully interoperable information systems, so this research will focus on social factors as it seeks to explain the gaps that have been observed in practice. Acculturation theory, (Berry, 1979; Kottak, 2005; Miller -Loessi & Parker, 2006; Soaries, 2003; and others) will be used to examine the effects of the interchanges between business and IT cultures. The mapping of language and customs across these domains will be understood through the concepts of Social Constructionism, specifically the so-called SCOT (Social Construction of Technology) proposed by Pinch and

Bijker (1984). Mindset theory will be used to look for any cognitive bias about how the teams interact, particularly with respect to actions, gaps, and goal setting.

The research will therefore be guided by the conceptual model presented below as Figure 2 Initial Conceptual Model.

FIGURE 2
Initial Conceptual Model



The independent variables that mediate Group Understanding of Process, Information, and Tool Integration of the Enterprise are the Culture of the Business Functions, the Mindset of the people in those Functions, and the Socio-Technological Constructions that are used to express agreed understanding. This is moderated by the Business/IT Boundary Spanners who advise them.

Breaking this model apart, the Business Functions each have their own unique cultures, that because of the interplay of thir own unique identities and communication norms

will hinder the Functions working together to come to a common agreement on the processes, information models, and the IT tools that embody them.

The mindset that the members of the business functions have as they approach developments will create a cognitive bias that will influence the understandings and actions of the groups.

The Socio-Technological Constructions that are the understandings of how the processes and information models represent the actual business transactions, and the way in which these should be embodied in the IT tools, together with the way in which these constructions are formed and agreed will influence the group understanding.

The group understanding of the process, information, tool triple will be moderated by the role of the Boundary Spanners, as they break down communication barriers through their knowledge of the business and IT that extends past the functional silos or chimneys.

The quality of the process, information, tool triple, which is the measure of interoperability, will influence how well the business is able to perform its daily transactions. This can be measured by monitoring Key Performance Indicators of the business.

LITERATURE REVIEW

This literature review is presented in two major sections the development of the concepts around the social aspects, and the technical aspects of how to achieve interoperability. The first section includes three sub-sections, the first dealing with acculturation, the second with the nature of socio-technical interactions, and the third dealing with mindset. The second section includes three sub-sections, the need for interoperability in

the enterprise, the technical aspects of methodology and architectural frameworks, and ongoing governance.

Social Aspects

***Acculturation*.** Kottak (2007) states that *Acculturation* is the exchange of cultural features that results when groups come into continuous firsthand contact; the original cultural patterns of either or both groups may be altered, but the groups remain distinct. Miller-Loessi and Parker (2006) provide a working definition of culture (originally proposed by James House in 1981), noting, "a culture is a set of cognitive and evaluative beliefs – beliefs about what is or what ought to be – that are shared by the members of a social system and transmitted to new members." While this definition does not prescribe a specific type of social system, the traditional notion that culture should only be interpreted as a nation or nation-state constructs has prevailed in most acculturation research. Dohrenwend and Smith (1962) challenged this norm, concluding that other social systems are appropriate. Miller-Loessi and Parker discuss the issue briefly, noting that the concept should be appropriate in most cases, but noting the difficulty of disentangling pre-existing cultural cross learning. This research will address acculturation in the setting of a business enterprise, conjecturing that business people (including managers, engineers, logistics experts, purchasing, and finance analysts), and their counterparts in information technology constitute two distinct organizational cultures. Understanding what are the new ideas presented to research subjects, versus what they have learned in prior experiences, will help to disentangle the threads of the acculturation process.

There are two models that may be used in acculturation studies, the cross-culture model, as described by Miller-Loessi and Parker (2006), and the unicultural model that has in

the past been the primary approach. In describing the two approaches, Berry (1979) notes that the former assumes neither culture is dominant while the latter assumes a dominant and a non-dominant culture. This research will look at the two cultures, Business and IT, and determine which model applies based on the flow of ideas (Berry, 2005) ; a pre-dominance of ideas from one culture will be used as an indicator that that culture is dominant (Thurnwald, 1932).

Basso (1967) describes language as being "a notoriously flexible instrument that registers changes in cultural content more sensitively than any other element of culture." The use of language can therefore be a key indicator to show that acculturation is taking place. It would seem that the discovery process should attempt to be sensitive to forms of language used in IT and business parlance, either verbally or in written or graphical notations.

While the results of acculturation is seen in language, there may be other factors involved, such as other aspects of group values, experience, or physical dispersion of teams, which play a part in defining the group cultural identity. Berry and Annis (1974) discuss acculturative stress, which is the stress that is created in the individual as a result of the acculturation taking place. They propose that the level of stress is a function of the cultural and behavioral difference between the communities, as well as the level of pressure that is applied to the process to acculturate.

Soaries (2003) showed how this problem of acculturation could be bridged by people sufficiently capable of operating in the two cultures. While his work focused on the race – nation – state cultural aspects, this set of theory is able to transcend that and be applied to other areas to help to explain the breakdowns in expected performance (Dohrenwend &

Smith, 1962). The research will consider acculturation as one of the possible causes of socially instigated communications breakdown affecting interoperability.

Socio-technical interchange. Social Constructionism posits that social constructs are artifacts of a particular culture, created through an on-going process of human choice. Pinch and Bijker (1984) first applying this to the domain of technology, suggested that the sociologies of science and technology could share a common framework and demonstrated that over time, groups of people come to a common understanding of a technological artifact, through a process of choice.

An excellent example was the acceptance of the pneumatic tire. The tire was originally proposed as an anti-vibration mechanism by Dunlop to smooth the ride of the machine. It was met with a great deal of rejection from many quarters, for a variety of reasons, including; aesthetics, practicality of maintaining inflation, and increased likelihood of skidding on wet surfaces. It was only when the pneumatic tire was quite by chance shown to increase the speed of the machine on the racetrack that the public accepted the technology. A cross-cultural understanding only stabilized when one culture (bike racers) chose (or constructed a view) that was acceptable to the other cultures involved (bike riders, bike producers, bike writers). The original artifact, the tire as a vibration reducer was rejected, even though it was the original reason Dunlop proposed its adoption. In the paper they describe the rapid up-take of this approach to many domains of study. Further research in this field yielded examples as broad as cochlear implants (Garud & Rappa, 1994), courtroom patent disputes (Cambrosio, Keating, & MacKenzie), and international standardization in telecommunications (Schmidt & Werle, 1994). The application to enterprise integration seems to be well within the bounds of usefulness of the approach.

The different cultures, IT, and potentially each of the different business disciplines, Engineering, Finance, Logistics etc. will have created their own meaning of many artifacts. They will likely have different views as to what is a Part, or what a Data Model depicts for example. The meaning they bring with them into the development teams will likely be different, and will likely change over time as the teams work together. In fact as they return to their home organizations to review results, and plan deployments their own modified means will give rise to further issues of acceptance. The research will not only have to be sensitive to these constructions and their change over time, but should be able to use the stabilizing agreements as further evidence of acculturation.

Mindset. Gollwitzer (Gollwitzer & Moskowitz, 1996) describes the impact of mindset on goal pursuit. When a person adopts the appropriate mindset at the various phases of goal pursuit, (pre-decisional, pre-actional, and post-actional) the stages of that pursuit are more effectively traversed. For goal setting (pre-decisional) a deliberative mindset seems most conducive. This mindset can be accomplished through intensive weighing of desirability and feasibility attributes of the goals. On the other hand, an implemental mindset is more appropriate at the implementation (pre-actional) phase. This mindset can be established by planning the implementation of these goals. Specific attributes of these two phases documented by Gollwitzer are:

- Goal Setting:
    - Subjects are more open minded in processing available information.
    - Heeded information is processed more effectively, while peripheral information is also encoded.

- Decision making information is processed more efficiently than implementation information.
- Desirability information is processed in a more impartial manner.
- Feasibility information is processed in a more objective, non-illusory manner.

- Implementation :
  - Subjects are more focused, and tended to discard /ignore irrelevant information (Gollwitzer, 1996).
  - Subjects are very effective in processing implementation information (Gollwitzer et al., 1990).
  - Desirability information is processed in such a manner that pros are favored over cons.
  - Feasibility information is processed in such a way that illusory optimism is favored.
  - This optimism provides a further illusion of control over uncontrollable outcomes (Gollwitzer & Kinney, 1989), and a greater sense of personal capability and behaviors.
  - Mood or self-esteem of subjects is also raised (Taylor & Gollwitzer, 1995).

Uhlmann and Cohen (2007) demonstrate further impact of mindset in a study of gender discrimination. They found that a self-perceived sense of objectivity gave rise to a "I think it, therefore it's true mindset". While their work focused on hiring discrimination, they state that the basic principles dovetail well with research on naïve realism and ambiguous/subjective judgment discrimination theory.

Rottenstreich and Kivetz (2006) researched decision making without likelihood judgment. While by their own statement their findings do not provide definitive answers as to

when each approach is favored, they do document the frequency and nature of probabilistic and non-probabilistic mindsets and their effects on decision making in the face of uncertainty; establishing that non-probabilistic reasoning is used more extensively than previously believed.

This body of literature, taken together, demonstrates that mindset can be a key factor in determining action and cognitive behaviors, particularly in uncertain or highly complex situations. The nature of enterprise information systems is to be complex, as they by their nature they cover all the aspects of the enterprise that are automated, both transactional and analytical, through each of the major business activities (product creation, manufacturing, logistics, supply chain management, purchasing, finance, etc.). It would therefore seem that mindset would be relevant to the research question, and that the discovery process would benefit from being sensitive to it.

Technical Aspects

Interoperability across and between enterprises is key to effective collaborative businesses. The expected breakdown in interoperability capability is at the human level, resulting from the previously cited social factors. It will be important, however, for the research to show that the necessary technical elements are in place, otherwise the failures identified could potentially be attributed to other causes. A basis for interoperability is therefore next considered, and an approach to good practice in this area is described. Anaya and Ortiz (2005) state that a way to achieve effective collaborative businesses is to build good Enterprise Architecture Definitions, using any of the available frameworks. They illustrate their approach using the Zachman model; a framework proposed by John Zachman, which has become the foundation of most approaches in practical use today (see Appendix).

Architecture definitions describe the building blocks of enterprises (Goethals et al., 2007), their processes, their information models, the relationships between them, and the ways that organizations interact with them. These definitions provide the framework for designing and maintaining the business processes, the information systems, and the methods used by people in organizations to work with them. So for example, an enterprise architecture definition might define what is meant by a Purchase Order (PO), who can create or amend them, and how they would use a Purchase Order to buy a new piece of machinery. They might describe related processes, so in an integrated approach, the issuance of a PO for a new machine might alert the facilities maintenance team to the need to add this machine to their regular schedule.

As the pace of change increases, enterprises find themselves needing to react faster, and in a more agile manner. Vernadat claims that agility implies that interoperable enterprise systems (reconfigurable systems made of IT components) are best achieved through disciplined standards management. He builds on a European Integration Framework (EIF) that suggests three levels that need to be managed:

- Technical (data and message)
- Semantic (information and those services that use it)
- Organizational (business unit, process, and people)

Vernadat describes a series of waves of integration that have occurred over time: Data Integration, Object Brokering (consistent chunks of data are thought of as being objects, and are managed by a set of brokers), Business Process Modeling, Enterprise Application Integration through hub and spoke approaches, and Service Oriented Architecture (SOA). SOA is an approach to enterprise architecture that suggests that information should be

managed by a consistent set of services that implement the business processes. The waves are a useful measure of the level of integration in an enterprise; the critical elements that until recently have been missing from most, if not all, enterprise IT implementations are:

- Non-standards based approaches (or proprietary standards at best)
- Tight coupling or monolithic architecture (can only talk among themselves)
- Synchronicity (no ability to function if one service is temporarily unavailable)
- Poor performance when many component systems have to be connected

At a technical level then, there appears to be available a consistent solution set to deliver the required level of interoperability. Semantic Interoperability, that is the ability for components of the system to be able to work together based on implicit or explicit meanings still requires further work to be ready for full-scale implementation, however standards based approaches provide an adequate bridge at this point.

An alternative approach to standards to guarantee agility and interoperability is to use a systematic engineering approach (Kim et al., 2006). Kim describes this in the context of a Virtual Enterprise (VE) that is a group of enterprises linked only through their interconnected information systems. The authors describe the set of concepts that when connected form an effective model for a VE:

- Multiple viewpoints for people with different roles in different organizations
- Varying information and process granularities (managing a list of parts for a whole vehicle, or for maybe just a windshield wiper)
- Abstractions (knowing that the red food mixer I bought yesterday, is part of a larger set of kitchen appliances, and in turn part of a larger but different set of electrical devices

- Different life-cycle phases, information that is still being developed versus having been published for broader consumption

A systematic approach is also illustrated by Baina, Benali, and Goddart (2006), they first make the case for the need for a model that supports collaboration across heterogeneous networks, that is networks comprised of unlike components, with differing semantic and technological standards. They validate their argument by evaluating the difficulties caused by differences in how processes are presented to users, how they are dynamically connected, and how they are enacted in the system.

Evidence of either or both of these approaches, use of enterprise frameworks, or systematic engineering, will be sought through the interviews, and through examination of pertinent technical project documentation.

***Architecture models using a complete and consistent framework establish the optimum design*.** Perhaps the most critical aspect of systems integration work is the availability of good models of business processes and information. These can be used to align information across disparate processes, computer systems, functional activities, and regions. A layered architecture model brings together the key artifacts of the systematic approach. Goethals et al. (2004) assert that the most comprehensive framework is the Zachman model (see Appendix). In this practitioner's experience, this is a reasonable statement, and Urbaczewski and Mrdalj (2006) make a similar claim in their paper on EA (Enterprise Architecture) Framework comparisons.

The descriptions in each layer tend to be model based, and are abstracted to only cover content that is pertinent to defining structure and relationships (Leist & Zellner, 2006).

A general conceptual model is created for each of the architectural descriptions, which is applied to each of the elements of the framework:

- Technique – how to model of the element
- Specification Document – the form and content of the documents that describe the architecture element
- Meta Model – the linguistic rules and conventions of the technique
- Procedure Model – how to apply the modeling technique
- Role - who creates and maintains the elements, or the element models and descriptions

Some criticisms of the Zachman model have been made in the area of lack of defined methodology to arrive at the enterprise artifacts; several authors describe methodological approaches to manage interoperability. Consistent modeling practices, traceability between elements of the model, and analysis of the relationships between the model elements are key to achieving the desired results. The model has to be aligned from the highest level of the Business Architecture through the lowest levels of the individual information artifacts.

Braun and Winter (2007) surveyed Enterprise Architecture literature, and state that an EA has five essential layers that together with a formal, or semi-formal metamodel guarantees consistency:

- Business Architecture
- Process Architecture
- Application Architecture
- Software Architecture

- Technology Architecture

Pereira and Sousa (2004) list the key issues with the Zachman framework in terms of its lack of consistency caused by the absence of methodological standards. They propose a conceptually simple traceability between the artifacts, based on dependency as a solution, and illustrate such an implementation.

Anaya and Ortiz, (2005) define the difference between abstraction (layers of the EA model), and granularity, layers within an individual cell of an EA. They describe information flows as being links between the *What* and *How* artifacts that will ultimately show where interoperability issues will exist, they appeal to Business Process Modeling methods for this approach. They further define general relationships between EA artifacts as being of two kinds, Impact (occur across different columns) and Causal (occur within the same column). They state that integration issues will occur between these relationships.

Emmerich et al. (2001) provide an implementation overview of a typical collaborative system that has been architected using a framework. The implementation is assessed against a number of factors:

- Business Requirements
- Scalability
- Performance
- Reliability
- Availability
- Security

- Changeability, and the
- Use of Commercial Off The Shelf Software (COTS)

In addition to the high level implementation model, low level information models are also critical. Peckham and Maryanski (1988) describe the relationship between External, Conceptual, and Internal levels of modeling enterprise information. They also look inside the Conceptual Model, and identify the key concepts that make a rich model. It goes down a further layer and describes the components that are used to model the key concepts of the conceptual model.

At the next level of granularity, Ram (1995) provides the foundation for a complete and consistent approach to building a semantic information model. The author first of all describes a semantic model, as being a set of objects with relationships between them, and of properties of the objects. Ram uses the term semantic model rather more broadly than some, to include conceptual models, entity-relationship data models etc. She defines the fundamental concepts in this semantic model as: domains, entities, entity classes, entity members, and relationships. She describes relationships between entity class members and properties of entity class members in detail.

The complete set of architecture concepts extend from the highest levels of granularity (the enterprise) through to the lowest level (individual data items). This set is able to define a semantic information model for the complete enterprise, and therefore to provide the basis for interoperability across and within enterprises.

Ongoing Governance Is Required To Drive Out the Business Value

Once the information and process modeling has begun, it becomes important to have senior sponsors to both agree to, and maintain these models, and ensure that they are

consistently implemented. Consistent attention is required to ensure that the planned changes generate the desire results for the enterprise, which in my experience requires experimentation and possibly a year or two living with the new capability. Heier et al. (2007) argue that improved IT Governance drives increased business value. They look at five key drivers for improved IT performance:

- Increased IT pervasiveness – strategic IT issues require cross functional business decision making
- Compliance requirements – audit and legislative pressure following Enron and Sarbanes-Oxley
- Return On Investment (ROI) pressure – need to drive IT investment from corporate priorities
- Strategic IT sourcing – complex offshoring and outsourcing are becoming increasingly common
- Cost control – IT costs continue to increase, causing added oversight

In a similar manner to the use of architectural frameworks, IT governance approaches have been established. The two key efforts are COBIT, Control Objectives for Information and related Technology, and ITIL, Information Technology Infrastructure Library. COBIT is a best practices governance framework, created by the Information Systems Audit and Control Association. ITIL is a set of concepts and techniques for managing IT; they are published by the United Kingdom's Office of Government Commerce (OGC). From a business perspective COBIT seems to be the more germane.

COBIT establishes a framework of four Domains; Planning and Organization, Acquisition and Implementation, and Monitoring. Each Domain is split into a number of Processes, numbering thirty four in total across the domains. Seven information criteria are

defined; Effectiveness, Efficiency, Confidentiality, Integrity, Availability, Compliance, and Reliability.

A number of approaches to ensuring consistent implementation of the COBIT model have been suggested. For example, Hussain and Siddiqui (2005) created a compliance matrix that provides a consistent approach to compliance evaluation. Raghupathi (2007) has described a simple conceptual model to ensure completeness and consistency of governance, using a two dimensional grid. On the x-axis is organizational focus, and on the y-axis is accountability and processes. Organizational focus is divided into three areas, Internal, External, and Extended. Accountability and processes is similarly divided into three areas, Operational Standards, Strategic Value-added, and Citizenship and Public Good.

Simonsson and Ekstedt (2006) describe a conceptual framework built on a set of statements about IT governance. The statements either explicitly or implicitly refer to IT Governance, either defining it, or describing something that implies or affects it. They are categorized by the approach used by the Roman Marcus Fabius Quintilanus, using the interrogation pronouns, Who, What, Where, By what means, Why, How and When. This is similar to the Zachman framework for Enterprise Architecture, which is immortalized in the words of Rudyard Kipling, *"I kept six honest serving men. They taught me all I knew. Their names are What and Why and When and How and Where and Who."*

Delpierre et al. (2004) established a framework that looked at eight different pieces of corporate performance meta-data to measure effectiveness of governance: Authors, Nature of the tested system, Name of the system, Number of participants, Length of trial, Domain, Judgment criteria, and Results.

Governance then, seems to be amenable to similar techniques that are used to define and manage completeness and consistency of the architecture; both at the time of development, and on an ongoing basis after implementation.

SELECTION OF THE RESEARCH FOCUS

This research will focus on work primarily in the Bill of Material domain. Interviews with engineering, purchasing, and logistics business groups, as well as with their respective IT support organizations at Ford Motor Company will be the primary data gathering effort.

The interviews will establish a baseline of experience, looking into how well Bill of Material information structures interoperate across various functional groups, who are both users of the data, as well as in many cases creators.

RESEARCH DESIGN

Methodology

This research will develop grounded theory by conducting qualitative research using semi-structured interviews with practitioners. Qualitative research is appropriate for this study because it is attempting to discover the broad themes of social interactions that may be responsible for the breakdown of capability in enterprise integration developments. Both quantitative and qualitative approaches have been used in this research arena, with the qualitative work encompassing in-depth case studies, as well as ethnographic studies (Thurnwald, 1932; Cambrosio et al., 1990; Schmidt & Werle, 1993; etc.). This research will be of an emic nature and as such qualitative approaches appear to be more appropriate; etic work in this domain appears to have been more statistical in nature (Berry, 1979; Uhlmann & Cohen, 2007; etc.).

Sample

A minimum of twenty practitioners will be interviewed, representing business practitioners from a number of functional activities, and their corresponding IT counterparts.

Consideration was given to including other automotive companies in the research, however their basic structures and approaches to this work are broadly similar, and it was felt that the ability to focus on one organization would allow better comparisons to be made, through more consistent examples. It would also permit a broader range of functional groups (purchasing versus engineering) to find out if the more technical business professionals experience similar acculturation issues.

***Business interviews*.** The research will involve two *Bill of Material Creators* from each of engineering and logistics groups, as well as two *Bill of Material Users* from engineering, finance, purchasing, and logistics. The individuals chosen will be selected based on having experience with major information system implementations. The spread of creators and users, as well as different functional groups should provide sufficient diversity to ensure a representative set of data.

***IT interviews*.** The research will involve two IT professionals with extensive Bill of Material background from the engineering, finance, purchasing, and logistics BOM teams. This will provide the counterpart interviews to the business professionals. Fewer teams will be required, as the IT professionals are organized by business group, and serve both creators and users in the same group.

Data Collection

The data will be collected from June 2008 through August 2008, at a single Automobile manufacturer in the US Midwest. The first round of interviewees, representing a

senior management cross-functional grouping will be selected by the Group Vice President of Product Creation. That group will be contacted via phone, or e-mail to determine if they would be willing to be interviewed, if for any reason they decline, the Group Vice President would be asked for further nominations. Each person interviewed will be asked to nominate a small group of subject matter experts in their domain, and a random selection from that group will also be similarly invited, and upon acceptance of the offer to be interviewed, the research will be conducted. This process should provide a reasonably bias free sample. Guidance will be given to the business leaders that the subject matter experts should have at least four years of relevant experience, and have been involved with process or IT tool developments in the bill of material domain. The minimum of four years of experience will limit the available sample pool of potential interviewees, so that either a number of boundary spanners will be interviewed, or those interviewed will have experience with the boundary spanners.

The interviews will be scheduled on the engineering campus in a private setting. This will facilitate recording the face-to-face interviews, which will typically last between sixty to ninety minutes. An interview protocol will be used to ensure consistency, although the interview itself will be semi-structured, with deep dives into areas to ensure adequate granularity of response, as well as to allow the researcher to follow intuitive leads during the process. The protocol will be assessed at the midway phase of the interviewing to determine if additional question are warranted, and if other questions could be dropped.

Subjects will be recorded if they give permission, otherwise Fieldnotes will be gathered and a from memory transcription made. The recorded interviews will be stored on an encrypted hard drive, and professionally transcribed. Confidentiality forms will be signed

by the subjects, further indicating their permission to record the sessions.

Data Analysis

The recorded interviews will be listened to multiple times, and/or the transcripts read. The transcribed data will be coded using Qualrus software to categorize the meanings in the interviews. The analytical tool will be used to assist in the coding, and to build relationships between the codes to assist in both the merging, and the pattern/theme identification.

The coding process will commence with open coding, and then be cross checked against a top-down conceptual coding scheme for consistency. The insights developed from the coding process will be used to ensure that a sound body of literature is available to assist with modeling the set of concepts appropriately.

INTERVIEW QUESTIONS

A series of sixty to ninety minute semi-structured interviewed with experienced business and IT practitioners will be conducted. The intent of the questions will be to provide the basis of the research, to understand what has worked well and what has not worked well in developing and implementing Process, Information, and IT Tool programs. The questions will drive towards actual experience, and will seek to avoid theoretical or hypothetical assessments.

- Briefly describe your career, and your role in the company.
- Briefly describe the Bill of Material Process, Information, and IT Tool programs that you have been involved with.
- Describe how you work within cross-functional teams to develop and then implement Process, Information, and IT Tool programs.
- How do you assess the business value of a new program, and how do you assess the effectiveness of a program once it is developed?

- Describe how a program moves through its various phases, from the beginning to implementation. What are the major steps that you are aware of?

- In these types of programs what ways of working have you seen that are particularly effective, and particularly non-effective. Can you give me some examples?

- Describe the work products that you have seen the business people create for the IT people.

- Describe the work products that you have seen the IT people create for the business people.

- Which of the work products do you find helpful, and which ones do not seem to provide a great deal of value to you?

- Tell me about a particularly effective implementation that you were involved with. Why do you say that it was effective, and what things do you believe contributed to its success?

- Tell me about a particularly ineffective implementation that you were involved with. Why do you say that it was ineffective, and what things do you believe contributed to its problems?

- In your experience, how well do IT and business people work together? What are the contributing factors you have seen?

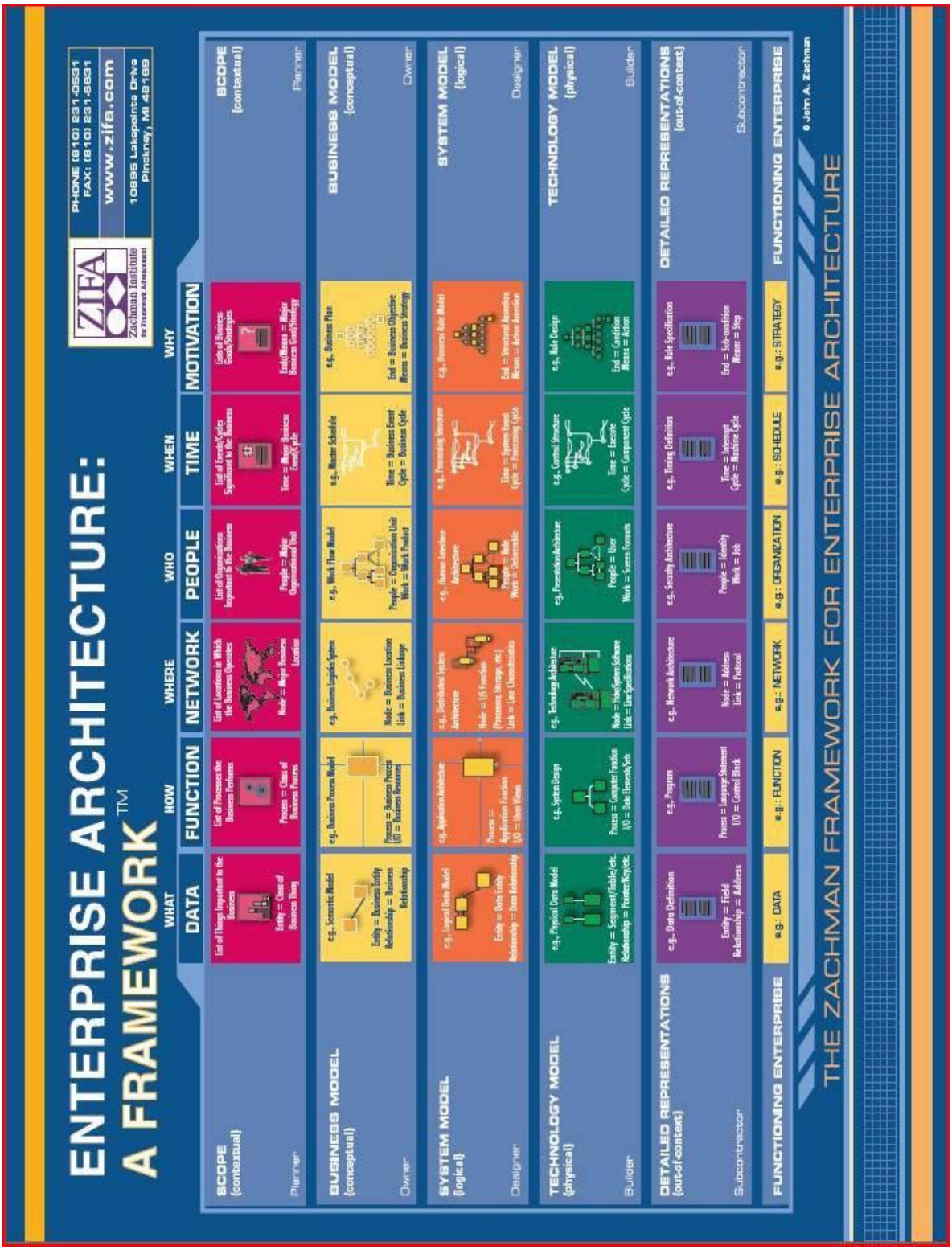
- How well prepared did you feel when you went through these types of program? What could have been done better?

- What type of training was provided? Did it help?

- What part time specialized teams have you seen being used to help with design/implementation? How effective have they been, and why do you think they were or were not helpful?

- AS you look back over your experiences with these types of initiatives, who were the people who were instrumental in driving success, what did they do that helped?

APPENDIX
Zachman Framework



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CULTURE CLASH - HOW SOCIO-TECHNICAL FACTORS CONTRIBUTE TO ENTERPRISE INFORMATION SYSTEMS INTEROPERABILITY

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CULTURE CLASH - HOW SOCIO-TECHNICAL FACTORS CONTRIBUTE TO ENTERPRISE INFORMATION SYSTEMS INTEROPERABILITY

ABSTRACT

Despite increasing need for interoperable enterprise-level information systems, achieving interoperability is persistently problematical. Our work highlights social factors as a major contributor to good design, development, and operating practices. The research was conducted at a technologically sophisticated Fortune 50 company where design artifacts suggested by the literature were found to be in place yet good interoperability between systems was not consistently achieved. The data suggest boundary spanners can facilitate interoperability by promoting shared meanings and mindsets that advance acculturation among cross-functional groups. Findings contrast with enterprise systems interoperability literature, which has focused mainly on technological factors to ensure good design and operational capability.

Key words: Acculturation; Business Process; Culture; Enterprise Information Systems; Interoperability; Mindset; Social Construction

INTRODUCTION

This study examines why achievement of interoperable enterprise-level information systems is persistently problematical – despite the increasing need for them. Systems must be interoperable to achieve required levels of collaboration within an enterprise. Fast paced business and technological change mandates flexible and agile processes and associated information systems − both within an enterprise and between it and others (Anaya & Ortiz, 2005). Changes might typically include businesses that have morphed from silo-based organizational entities to process centric operations, as well as virtual organizations that co-operate closely using electronic interchange. Further change has been introduced by financial pressures that have led to significant off-shoring of IT development, and major corporate collapses have renewed focus on security concerns such as access control, and intellectual property protection (Raghupathi, 2007). Technological changes such as the growth of the Internet, Business Process Management solutions, and semantic approaches to data management, for example Web 2.0 (Peckham & Maryanski, 1987) have arisen to facilitate integration in the IT landscape (Anaya & Ortiz, 2005), but have also compounded the rate of change that has to be digested.

Despite two decades of investment in Enterprise Architecture to provide necessary interconnections as described by Vernadat (2007), Anaya and Ortiz (2005), Braun and Winter (2007) and others, interoperability and integration challenges stubbornly persist. At the core of the challenge to increase flexibility and agility in and across enterprises is a complex network of arbitrary, poorly documented and understood business processes and information representations. These representations have to be aligned, extended, replaced, and mapped by humans, from varying backgrounds, with different levels of expertise (Anaya

& Ortiz, 2005).

Thus far, the literature has been silent on why technological change alone has not sufficed to meet the increased need for interoperability. This study focuses on the social factors that negatively affect development teams engaged in mapping and alignment work. It attempts to explain how varied business and IT groups fail to achieve sufficient clarity to adequately align systems, given the aggressive time schedules demanded by business conditions.

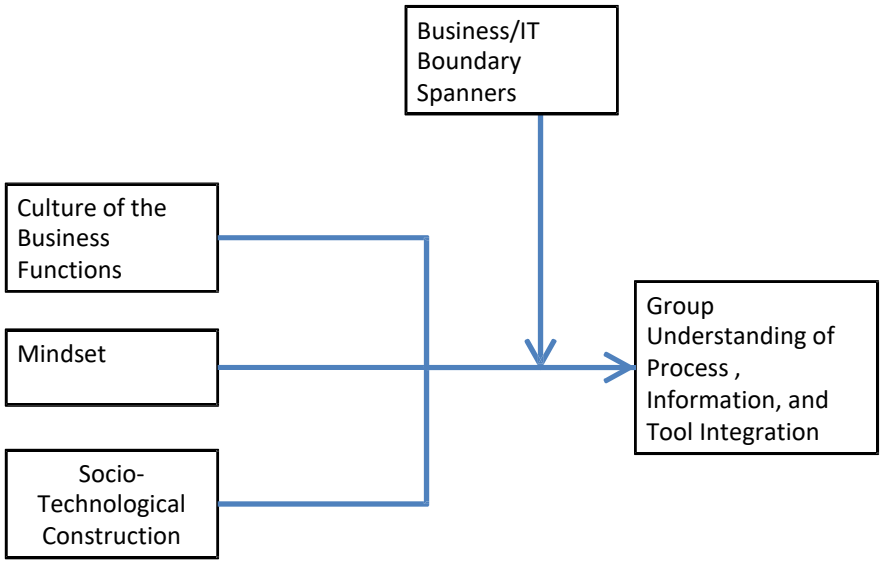
RESEARCH QUESTION AND CONCEPTUAL MODEL

How do social factors contribute to the success of enterprise processes and the ability of their respective information systems to work together?

The conceptual model presented below as Figure1 informed the design of an interview protocol that guided the conduct and analysis of semi-structured interviews with a sample of IT and business professionals.

The model suggests that Group Understanding of Process, Information, and Tool Integration of the Enterprise are influenced by business function culture, the mindset of the people in those functions, and the socio-technological constructions that are used to express agreed understanding. As the model indicates, we conjectured that this influence might be moderated by business/IT boundary spanners.

FIGURE 1
Initial Conceptual Model



Culture may be unique and specific to individual business functions and identities and communication norms may consequently hinder efforts by cross-functional groups working toward common agreement on how the processes and information models are embodied in the IT tools. The model implies that the mindsets of business function members may create a cognitive bias that will influence the understandings and goals/actions of the group. We conjectured that socio-technological constructions (understandings of how the processes and information models represent actual business transactions), how they are formed and agreed, and the way in which they are embodied in IT tools, may influence group understanding.

The group understanding of process, information, and measures of interoperability may be moderated by the role of Boundary Spanners, individuals who break down communication barriers using business and IT knowledge that extends past functional silos or chimneys.

We wondered if the quality of the process, information, and tools will influence how

well the business is able to perform its daily transactions, measured by Key Performance Indicators of the business.

LITERATURE REVIEW

The literature review is presented in two sections. First we overview the development of the concepts around the social aspects of achieving interoperability, and thereafter we discuss the technical aspects of interoperability which Vernadat (2007) defines as the capability for systems to work together.

Acculturation

The influence of different cultures of the business and IT groups on each other, and as a result on the work of developing interoperable enterprise systems, is understood by looking at the acculturative processes that moderate understandings between the groups, and also result in stresses within the groups as they deal with each other. Kottak (2005) defines acculturation as the exchange of cultural features that results when groups come into continuous firsthand contact, when the original cultural patterns of either or both groups may be altered, but the groups remain distinct. Culture was defined by Miller-Loessi and Parker (2006: 530), based on the work of House in 1981, as "a set of cognitive and evaluative beliefs – beliefs about what is or what ought to be – that are shared by the members of a social system and transmitted to new members". The social system has, in practice, frequently been at the nation or nation-state level, but Dohrenwend and Smith (1962) concluded that other social systems are appropriate.

Two models that have been used in studies of acculturation are the unicultural model and the cross-cultural model described by Miller-Loessi and Parker (2006). Berry (1979) notes that the former approach assumes that one culture is dominant, which historically has

been the primary research focus (cultural impact on natives by colonizing powers), but that the cross-cultural model is useful when neither culture is dominant. Thurnwald (1932) argued that dominance of the source of ideas transmitted is an indicator of cultural dominance. Basso (1967) suggested that language, "a notoriously flexible instrument that registers changes in cultural content more sensitively than any other element of culture" is a key indicator that registers acculturation taking place.

Berry and Annis (1974) describe acculturative stress, which provides further evidence of cultural factors that are being exchanged; they note that stress levels are a function of the cultural and behavioral differences between communities, as well as the pressure to conform to an alien culture. Soaries (2003) asserted that acculturative stress led to socially instigated communication breakdowns that could be bridged by people sufficiently capable of operating successfully in both cultures.

Socio-Technical Interchange

Social Constructionism posits that social constructs are artifacts of a particular culture, created through an on-going process of human choice. This was first applied to the technology domain by Pinch and Bijker (1984) who demonstrated that people came to a common understanding of a technological artifact through a process of choice.

Pinch and Bijker noted five major concepts in Social Construction, the first being interpretive flexibility. They suggest that technology design is an open process that can produce different outcomes depending on the social circumstances of development. The second concept is the relevant social group, which is the embodiment of particular interpretations: “all members of a certain social group share the same set of meanings, attached to a specific artifact”. The third concept is design flexibility, which suggests that

technologies can have multiple meaning, and may therefore be interpreted by a social group. The fourth concept is problems and conflicts, that is different social groups interpret problems differently, and therefore multiple design solutions may arise. The fifth concept is closure and stabilization; which can occur through either rhetorical closure (a declaration is made that no further problems exist and that no additional design is necessary) or through redefinition (unresolved problems are redefined so that they no longer pose problems to social groups).

Mindset Impact on Goal Pursuit

There is a large body of literature on mindset. We were particularly interested in the impact of mindset on pursuing goals. Gollwitzer and Moskowitz (1996) describe this impact, noting that the stages of pursuit are more effectively traversed when an appropriate mindset is adopted. The pursuit stages are categorized as goal setting (pre-decisional), implementation (pre-actional), and post-actional. A deliberative mindset is conducive to goal setting, and an implemental mindset is conducive to implementation. Gollwitzer notes specific attributes of the goal setting phase as: (a) subjects are more open minded in processing available information; (b) heeded information is processed more effectively, while peripheral information is also encoded; (c) decision making information is processed more efficiently than implementation information; (d) desirability information is processed in a more impartial manner; and (e) feasibility information is processed in a more objective, non-illusory manner. He further notes the attributes of implementation as: (a) subjects are more focused, and tended to discard /ignore irrelevant information (Gollwitzer & Moskowitz, 1996); (b) subjects are very effective in processing implementation information (Gollwitzer, Heckhausen, & Ratajczak, 1990); (c) desirability information is processed in such a manner

that pros are favored over cons; (d) feasibility information is processed in such a way that illusory optimism is favored; (e) this optimism provides a further illusion of control over uncontrollable outcomes (Gollwitzer & Kinney, 1989), and a greater sense of personal capability and behaviors; and (f) mood or self-esteem of subjects is also raised (Taylor & Gollwitzer, 1995).

Uhlmann and Cohen (2007) found that a self-perceived sense of objectivity gave rise to a "I think it therefore it's true mindset a cognitive bias that can be a further factor in establishing inappropriate goals.

Interoperability as Key to Effective Collaborative Business

Anaya and Ortiz (2005) make the case that achieving effective business collaboration requires interoperable systems, and that these are achieved through good Enterprise Architecture Definitions. They cite the need for a suitable architecture framework, and illustrate the approach using the Zachman model, a framework that has become the foundation of most approaches in use today.

As the pace of change in commerce and industry increases, enterprises must be more agile. Vernadat claims that interoperable enterprise-class systems are best achieved through disciplined standards management. He suggests three levels that need to be managed; (a) technical (data and message), (b) semantic (information and those services that use it, and (c) organizational (business unit, process, and people).

An alternative to standards based approaches is argued by Kim, Lee, Kim, and Kim (2006) and Baina, Benali, and Goddart (2006) who both describe systematic engineering approaches. Preconditions for successful implementation suggested by Kim et al. (2006) are: (a) multiple viewpoints for people with different organizational roles; (b) varying

information and process granularities; (c) information abstractions, e.g. structured information categories; and (d) different life-cycle phases for information e.g. work in process versus published.

Architecture Models

As already noted by Anaya and Ortiz (2005), architecture models are best built on a suitable framework, such as the Zachman model, which Goethals, Lemahieu, Snoeck, & Vandenbulcke (2007) assert is the most comprehensive model available. These models have been described and characterized as layered approaches by numerous authors, including (Braun & Winter, 2007; Leist & Zellner, 2006; Pereira & Sousa, 2004; Urbaczewski & Mrdalj, 2006). Anaya and Ortiz suggest that integration issues will occur if the relationships between the elements of the architecture model are not aligned.

In addition to the high-level architectural models, low level models are required (Peckham & Maryanski, 1988). These authors describe the relationship between External, Conceptual, and Internal levels of enterprise information models. Our conceptual model contains the key information constructs, which can be described using semantic techniques outlined by Ram (1995). She provides the foundation for a complete and consistent approach to data modeling using objects and relationships between those objects. The objects themselves and the relationships can be described by a set of attributes or properties.

Ongoing Governance

As already described, humans are deeply involved in both the development and execution of enterprise information systems, Heier, Borgman, & Maistry (2007) argue that driving out the maximum business value of these investments requires ongoing IT Governance. They cite five key business drivers for improving performance: (a) increased IT

pervasiveness (strategic IT issues require cross-functional business decision making;) (b) compliance requirements,(both audit and legislative pressure following Enron and Sarbanes-Oxley); (c) Return on Investment (ROI) pressure, (the need to drive IT from corporate priorities); (d) strategic IT sourcing (complex offshoring and outsourcing are becoming increasingly common); (e) cost control (IT costs continue to increase causing added oversight).

In a similar manner to the architecture frameworks, IT governance approaches have been established (Simonsson & Ekstedt, 2006; Delpierre, Cuzin, Fillaux, Alvarez, & Lang, 2004). The two key efforts are COBIT, Control OBjectives for Information and related Technology, and ITIL, the Information Technology Infrastructure Library. COBIT is a best practices governance framework, created by the Information Systems Audit and Control Association. ITIL is a set of concepts and techniques for managing IT published by the United Kingdom's Office of Government Commerce (OGC). As with the architectural frameworks, a number of improvements to the model have been suggested, Hussain and Siddiqui (2005) describe a compliance matrix that provides a consistency check on application of the framework, and Raghupathi (2007) describes a simple conceptual model for ensuring both completeness and consistency.

In summary, it appears that from a technical perspective, a useful interoperable solution ought technically to be attainable if the necessary architectural building blocks are properly defined, if a suitable framework establishes that all the pieces are in order, and if an ongoing system of governance is in effect. This research looked for those factors to establish that technical factors are being credibly and appropriately applied during development and during execution of the enterprise systems.

METHODS

Methodological Approach

Qualitative research was conducted, using semi-structured interviews as the primary approach. This particular methodology is well suited to the generation of grounded theory to conceptualize and explain complex social phenomena. This approach is well documented by Glaser and Strauss (1967: 18), who describe its usefulness for both verification as well as generation of theory. Corbin and Strauss (2008: 12) describe the purpose of qualitative research as "to get at the inner experience of participants, to determine how meanings are formed through and in culture, and to discover rather than test variables". The qualitative method, then, was viewed as the most appropriate approach for this research, seeking as it does to discover the social factors that contribute to the capability to create interoperable enterprise systems.

In the development of grounded theory as described by Glaser and Strauss (1967: 28), data is systematically examined, to reveal patterns that help to conceptualize and explain it. Interviewees were encouraged to tell their stories, through the use of a flexible protocol, using examples that illustrated their views, as a means of getting at their experience and avoiding philosophical interpretations (Spradley, 1979: 85).

Sample

Five senior and thirteen middle managers of a single automotive OEM, located in the Midwestern region of the United States, participated in the study. Respondents included both information technology practitioners and their counterparts from a variety of business activities. Drawing participants from a single company permitted a broader grouping of business functions to assess differences between highly technical ones such as engineering,

and more commercially oriented groups such as purchasing and finance. It also provided the opportunity to hear versions of the same story from multiple perspectives to better understanding how meanings are developed and attributed to experiences and events.

We asked the group vice president of global engineering to nominate as interviewees senior managers representing four specific functional areas of the business – Engineering, Finance, Logistics, and Purchasing. After they were interviewed, we asked each senior manager to nominate middle management/specialist employees reporting to them as additional interviewees. We also interviewed 6 IT specialists nominated by IT management.

In all cases, the request was for people who were involved with the subject domain of Bill of Material, and who had at least four years of in-depth experience working in this area. Selection criteria included suitable experience and the expectation that participants would be candid about their experiences. All held undergraduate or masters level degrees, with the exception of one participant who held a two year degree.

Table 1 summarizes the interviewee pool.

TABLE 1
Interviewee Pool for Qualitative Study

Business Function	IT/Business	Senior Managers	Middle Managers
Engineering	Business	2	2
	Information Technology		1
Finance	Business	1	2
	Information Technology		2
Manufacturing Planning and Logistics	Business	1	2
	Information Technology		1
Purchasing	Business	1	1
	Information Technology		2

Data Collection

Initial contact with potential interviewees was made by e-mail following recommendation by their managers. The e-mails briefly explained the voluntary nature of the interview and the goals of the research. All interviews were conducted locally, in private, and in English. Maxwell's (1996: 91) situation-specific interview process was used to develop an interview protocol used with all participants. In total seventeen questions were used, although not all interviewees were asked every question. This was partially a result of having covered the subject matter in another part of the interview, or partly because later interviews started to focus on particular topics once another topic seemed to be exhausted, or because an interviewee had compelling stories in a particular aspect of the subject matter (Spradley, 1975: 67).

The interviews averaged a little over an hour. In all but one case the interviews were digitally recorded, and the recordings were then transcribed by a third party provider. The data was returned as a Rich Text Format (RTF) file, and was then edited to correct transcription errors and to remove identifying material. In one case, the interviewee declined to be recorded and an interview transcript was manually reconstructed from notes made during the interview. The edited transcriptions were loaded into coding software (QUALRUS) for further analysis.

Prior to the interview, the participants were reminded of the goals of the interview, and provided with an informed consent document. The use of probes to follow up on questions and to determine appropriate granularity was discussed to ease further their concerns about answering appropriately. The final question of each interview solicited further input from the interview about anything that they felt was relevant that had not come

up in the course of the interview.

Data Analysis

In grounded theory, analysis focuses on the generation of a set of concepts that can explain the research data. The data is broken down through a process of categorizing, and themes and patterns are observed that allow the data to be put back together in new ways (Corbin & Strauss, 2008).

The approach taken was first to open code the interviews using the Qualrus software. In open coding each section of data was read and re-read to capture "codable moments" – segments of discourse with meaning. This process yielded 482 codable moments that were subsequently categorized as seven themes; Acculturation, Acculturative Stress, Speaking Different Languages, Boundary Spanning, Social Construction, Mindset, and Good IT Practice. As the coding process progressed relationships between the initial set of 153 codes were developed, to both help with categorizing, as well as with understanding categorical relationships. In all, sixty-one sub-themes were used to link the initial codes to the seven themes. Fifteen of the initial codes were discarded in the final analysis, leaving a total of 138 codes. The sub-themes were linked, using a causal developmental hierarchy technique described by Boyatzis (1998: 137). The data was then re-coded using a conceptual approach based on the theoretical constructs of the preliminary conceptual model (Boyatzis, 1998: 33-37). The unit of analysis for this research (Boyatzis, 1998: 62) was at the level of the individual and the unit of coding was "the entire response, the paragraph, the sentence . . .", or occasionally a sentence fragment.

FINDINGS

Our analysis yielded four key findings:

- Acculturation between IT and business groups is evidenced by:
  - Assimilation of language and other cultural traits over time
  - Acculturative stress shown as fear, discomfort, and frustration
- Acculturation issues cause communication problems, which result in time delays, cost overruns, and failure to meet goals, but are mitigated by boundary spanners, from both IT and business groups
- Socially constructed shared meanings between groups and individuals contribute to difficulties in achieving interoperability goals because the process to arrive at clear goal statements is often iterative, and takes time
- Mindset contributes to inappropriate goal seeking/setting behaviors such as:
  - *Not Invented Here* attitudes
  - Overly constrained planning processes

Finding 1: Acculturation

1.1 Acculturation between IT and business groups is evidenced by assimilation of language and other cultural traits over time. Our data revealed significant differences between the cultures of business functions and IT, different business functions, and any one function and IT. Respondents described many aspects of culture differences, including organizational worldview or mindset, priorities, working practices, "big picture" implications, and details of every day work patterns. The importance of acculturation was stressed; design decisions that affect the usefulness of development projects, respondents revealed, need to be made with a clear understanding of both business and IT consequences.

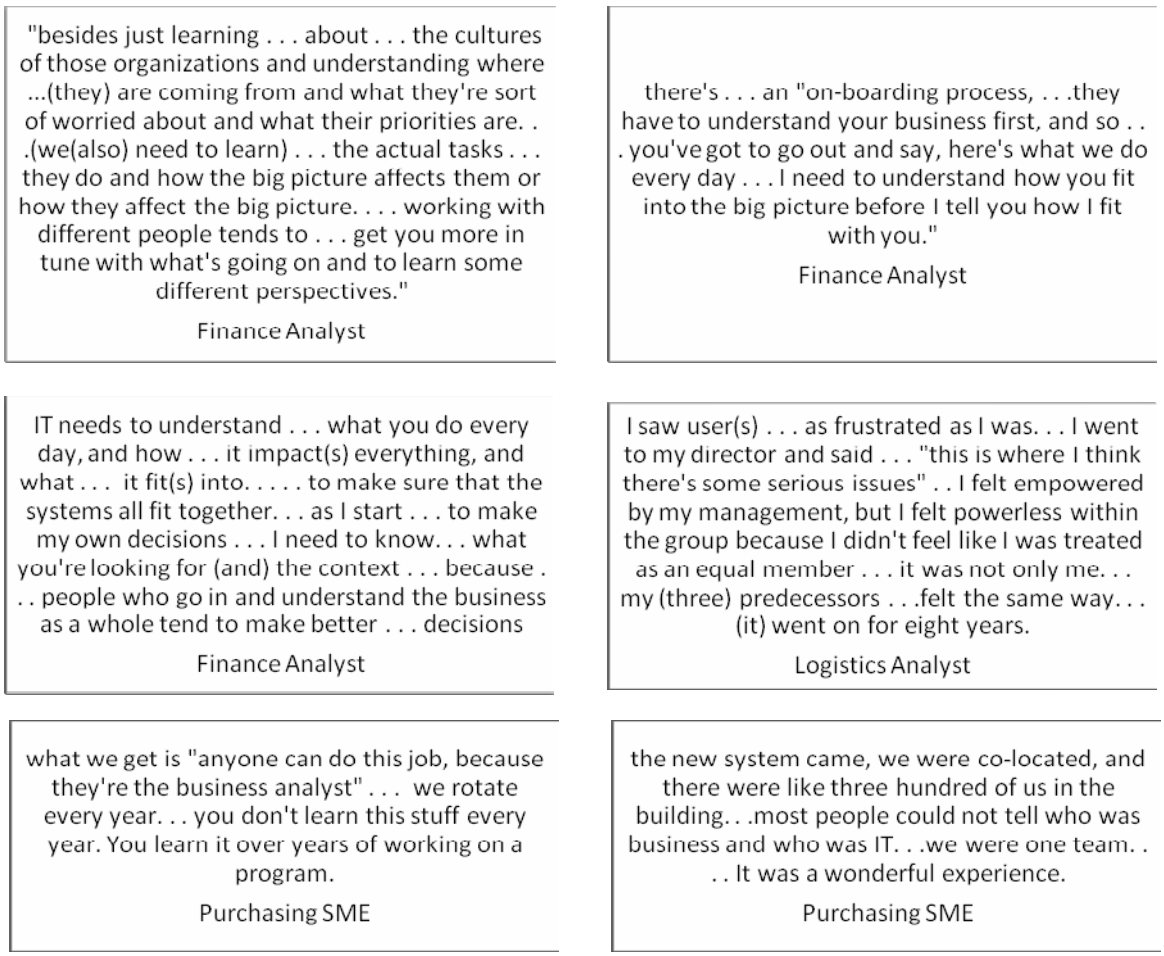
Our interviewees suggested that the time it takes for individuals within groups to become acculturated (and therefore effective) in working together is significant. They talked

in terms of years, not months, and described this assimilation as a major part of their careers. Absent this process, which a Finance Analyst describes as “on-boarding”, or a type of training, there is no shared understanding of player fit with others, and therefore no common ground to understand the big picture.

Respondents described documents that were created in the development process, and discussed their value. Most notably the business people saw little value in many of the documents that described current state process and IT landscape, whereas the IT respondents found these to be helpful. This reflect respondents’ comments about IT’s lack of business knowledge; these documents and their creative processes represent some formal acculturation processes, as IT people start to understand and think like business people during early high-level design processes.

There was evidence not only of acculturation, with both sides assimilating behaviors from each culture, but in at least one notable case a functional group (Product Development) used its strengths over an eight year period to dominate one project and to effectively disempower another functional group (Logistics). Evidence of positive acculturation, illustrated in Figure 2 below, was reported as resulting in "blended" business/IT teams who could step into one another's roles as required and whose original business or IT derivations were indistinguishable.

FIGURE 2
Acculturation: IT and Business Teams Learning About Each Other's Cultures



1.2 Acculturation between IT and business groups results in acculturative stress.

Acculturation as a process creates stress in the individuals that are engaged in it. The literature suggests that the effect is reliable evidence that acculturation is taking place, and describes a range of negative emotions as well as physical symptoms that may be used as indicators. We found stress evidenced as apprehension, fear, discomfort, and frustration, based on self-reports of our respondents. Our data, shown in Figure 3**Error! Reference source not found.Error! Reference source not found.,** revealed apprehension about

communicating with IT because of unfamiliarity with IT language, and inability to interact consistently with people from other cultures despite their expectations of providing leadership.

Fear resulting from mistrust between business groups was reported, this drove inappropriate decision making, which resulted in conservative, risk-averse solutions being championed. Consequent delays were caused as negotiations to minimize costly system redundancy were conducted in a closed atmosphere Feelings of discomfort were evidenced by one culture that was unfamiliar with the cultural traits of another; this was exacerbated when discussions between the groups were required. The reciprocal behavior evidenced by the group with the knowledge was frequently frustration; this cycle of discomfort and frustration further raised the stress level.

Attempts by IT and business teams to change workplace behaviors by modifying the current culture, without appropriate tools to ensure smooth change, resulted in negative emotional reactions of anxiety and frustration. These attempts by a dominant (management empowered) team to remove elements of pre-existing culture, and replace them with new cultural traits only became successful when fear of failure was mitigated. A sense of powerlessness was also reported by the non-dominant culture when the behavioral changes were being forced by a dominant culture. The affects of enforced culture change accords well with the literature on marginalization of one culture by another.

FIGURE 3
Acculturative Stress: IT and business Feeling the Stress of Acculturation

Finding 2: Communication Issues

2.1 Speaking different languages. Both IT and business respondents reported acute awareness that they speak different languages. Language as an obstacle to performance was identified as a problem not just between the two functional groups, but also between business groups, such as between groups in disparate regions, or groups with different product responsibilities. Respondents indicated that each group possessed the capacity to master the

language of other groups; however, this is a slow process that takes place over months or years, not over days or weeks. Our data reveals that language, or speaking the language, is a multi-faceted capability.

It includes simple syntactic capabilities, such as recognizing that “aluminum” in the US, is the same as “aluminium” in the UK. The different business groups have their own language, and find it difficult to believe they all do the same thing; this includes different technical approaches, English vs. Metric units, different spellings, etc.

Language also includes semantic capabilities, such as the ability for two groups to look at a set of requirements and mean the same thing when using the same words; at times, it was not until the software was delivered and they both realized they were on different tracks. This capability extends not only to words but also to data items, two groups can have the same item, but they are look at it, relate to it, and speak about it differently. The finance people have seen cost as an end in itself; the engineer sees it as just another piece of information, similar to the weight of the part, or its size.

Language further includes pragmatic capabilities, the ability to realize that misinterpretation has taken place, and to come back to basic understandings and rebuild the more complex understanding again. In one experience, our respondents described required a three-month period before the IT groups were willing or able to use the same language. This finding is particularly interesting, as the two IT groups are in the same region, both work in the same domain, Bill of Material, and differ only in that one has an engineering, and the other a manufacturing customer.

FIGURE 4
Speaking Different Languages: IT and Business Jargon, Meanings, and Stories

So even two very closely related groups take a three-month period to acculturate on basis of language.

Our respondents also used language as a synonym for knowledge, or cultural traits, in particular detailed business knowledge. IT's ability to learn the business culture, was seen as a necessary, but not sufficient condition for success in developing interoperable systems to meet the business requirements; embedding the IT teams with the business to leverage this capability was seen as positive. Conversely, when IT behaved in a dominant manner, forcing

its language on the business, this was seen as inappropriate because IT was viewed as a service organization. Success was also attributed to business people who had become effective users of the IT language, thus suggesting that language learning capability is bi-directional.

2.2 Boundary spanning. As illustrated in Figure 5, many respondents identified the existence of "boundary spanners" − people with knowledge and facility in both business and IT. These people were either individuals in business groups or members of recognized organizational entities who worked between business and IT to translate requirements, act as a focal point for systems planning, and/or negotiate trade-offs.

Boundary spanners, our respondents agreed, might emerge from either business or IT. Their effectiveness, the interviewees revealed, derives not only from their ability to speak different languages and to translate, but also to articulate positions of common ground between disparate groups. Boundary spanners were described as understanding what it takes to be successful in more than one culture, and as having the personality traits that elicited the trust and confidence of multiple parties

Respondents recognized and appreciated the difficulty – but also the limitations − of the boundary spanner's role. While endeavoring to span the gaps between groups, synthesize business processes and information flows, provide a common knowledge base and emphasize forward thinking, these individuals cannot be expected, our sample agreed, to know every detail of the business with the same intensity of someone "in the trenches."

Finding 3: Social Construction

Our respondents revealed that the process of finding shared meaning is a long and sometimes difficult road, Figure6. Characteristic comments included: "transformation, just

grinding through,"; "it's hard to get people to find a common place,"; "it was many hours of going through different aspects," etc. Respondents described the process as one of personal transformation, observing that once individuals have gone through the process they become allies in getting the word out, convincing others about this new point of view. This process, interviewees agreed, is exacerbated by language difference; but meanings have to be ascribed to items where the language is identical. For instance, in the discussion around the meaning of a part in the last quote in Figure 5, there is no language difference with the word "part", but a deeper level discussion about the context of how the word is used in a technical sense.

Respondents described how this process moves backwards and forwards, punctuated with participants questioning, probing and second guessing one another or other business partners − all with the end purpose of forcing out some new shared meaning that the groups could settle on. Respondents concurred that considerable time was required to agree on terminology, even in processes that had been in operation for a long time. The lack of written descriptions is often a barrier to progress that must to be overcome by dogged work. One respondent's definition of a commodity revealed a great deal about what is going on. PD and Purchasing had used a term for many years, but discovered they had fundamentally different approaches to categorizing parts, and were expected to work out a common basis that might meet both groups' needs. This suggests it is more than just agreeing that something means X to you and Y to me – rather, it is the process of finding a new shared meaning, Z.

FIGURE 5
Boundary Spanning: Subject Matter Experts Helping to Bridge the Divide

The process includes both an element of sharing semantic information to help determine the meaning, as well as an element of convincing others about which meaning to adopt. The process of sharing and convincing can be arbitrary, at times the point of agreement was reached to meet project deadlines, or in other cases agreement represented a

mutual accommodation that was good enough to let the project proceed.

Our respondents also noted learning, evidenced by changing positions over time, as well as a degree of personal conviction required before adopting a new meaning, suggesting that time may be a factor in embracing shared meaning. An IT analyst describes studies done to determine what a part means to different stakeholders. Basic words, like commodity or part, turn out to have different meanings to different stakeholders; it takes a lot of working through, before everybody is on the same page.

FIGURE 6
Social Construction: Developing Shared Meaning between Individuals and Groups

Finding 4: Mindset

Our research, shown in Figure 7, revealed that mindset influences goal development and the approaches team members take to reach those goals. Our respondents described the interaction of the environment and the underlying value set of the functional groups, and the mindset that was engendered in the respondents. Individuals in the finance group were frequently not rewarded for demonstrating personal initiative, which contributed to the development of a conservative mindset. The conservative mindset enabled a careful focus on setting rational goals that were achievable, and thus the teams worked iteratively towards the larger goals, but always in control, and usually meeting goals.

The iterative approach was further encouraged by an environment of limited funding, and a bias towards rapid action. The desire for perfection is thus kept in check, and a slow, methodical working approach is replaced by a more iterative approach accepting of compromise, and the need for redo's. Prior to the implementation phase, the need to develop a mindset for planning, rather than action was mentioned by respondents. This mindset benefits the overall program, as the pre-disposition is to look ahead, and focus effort on removing downstream obstacles, as opposed to meeting them when they arise. A further improvement to the environment that would create a better planning mindset was staffing teams with generalists. The lack of cognitive bias of "purists", people for whom there is only a single approach to implementation and for whom each project becomes a struggle if they are required to operate outside of their comfort zone, allowed greater freedom of goal choices, and therefore a higher likelihood of selecting an optimal strategy.

Conversely, dogmatic approaches caused people to approach project and budget planning sessions with a bias toward retaining or cancelling projects based entirely on the

dogma. Once the dogma had taken hold, the planning decisions were largely irrational. Other mindsets such as the classic *Not Invented Here* (NIH) syndrome, or failing to deal appropriately with the "Sunk Cost" problem, could also impose inappropriate constraints on planning teams. In the Sunk Cost model, once resources are invested in a project, the future course of action is best determined by rational thought, pretending that the project is in a green field state; but people look back at the path trodden and the resources expended, and make irrational decisions.

FIGURE 7
Mindset: Cognitive Bias that Influences Goal Orientation

DISCUSSION

Our research suggests that the union of dissimilar functional groups in cross-functional teams challenges the development of successful, interoperable enterprise systems. Boundary spanners are needed to facilitate shared meanings and mindsets and promote acculturation. Our findings contrast with enterprise systems interoperability literature, which has focused mainly on technological factors to ensure good design and operational capability. We suggest that the failure to create interoperable solutions when focused solely on technological approaches leaves room to consider other factors that may account for some of the problems. Our work highlights social factors as a major contributor to good design, development, and operating practices. The research was conducted at a technologically sophisticated company where design artifacts suggested by the literature were found to be in place yet good interoperability between systems was not being achieved consistently.

As was evidenced in the findings, acculturation, social construction, and mindset may impact interoperability. Boundary spanning behavior moderates these relationships to improve the capability to develop interoperable systems. In this section, we present a brief discussion of these points, and then integrate them using a system interaction model.

Technical Artifacts

Interoperable enterprise-level systems may be designed by using systematic approaches to information and process modeling and employing enterprise architecture frameworks to ensure that all the appropriate artifacts are developed (Anaya & Ortiz, 2005, Goethals et al., 2007; Kim et al., 2005). A key goal of our research was to understand if these artifacts and approaches were being pursued. Adherence to the technical aspects of the work, and yet failure to deliver interoperable results, would indicate other necessary conditions to

achieve interoperability. Respondents were questioned regarding their methods for system and process development and were asked for examples of what did and did not work well. While not all respondents valued all of the artifacts produced, the systematic development approaches used, and the lack of reference to artifacts that should have been created (and were not) suggests a high level of conformance to the required artifacts. The catalog of artifacts included scoping and chartering document requirement specifications, and process and information models. In addition, ongoing governance structures were consistently cited. Our findings indicate that non-technical factors were contributed to the failure to deliver interoperable systems.

Boundary Spanning

Our respondents described time delays and frustration working in cross-functional teams Respondents cited insufficient time for the different groups to understand each other, exchange information, and build a sufficient shared knowledge and skill base to develop the required level of interoperable solutions. As observed by Miller et al. (2006), "over time, firsthand contact results in acculturation, the sharing of beliefs about what is or what ought to be." Our respondents reported that the timeframe for acculturation to occur in some teams, however, ranged from several years to a significant portion of an individual's career. Project teams that required shared knowledge faster than normal acculturation processes would permit facilitated its exchange by using boundary spanners to bridge the two cultures. Our respondents recognized the value of the boundary spanners, although the clarity of their role was not explicitly understood, as evidenced by the lack of strategic use of their skill sets.

Social Construction

The Social Construction of Technology (SCOT) model fits the experiences of our

respondents well, explaining much of the challenge of building alignment across cross-functional teams. Developing shared meaning can be both time consuming and arbitrary. This results in delayed goal attainment and/or goals that are inappropriate from a behavioral perspective or are inconsistent with organizational strategy. Five core concepts of social construction identified by Pinch and Bijker (1984), which were described in detail in the literature review, were evident in our interviews with respondents. The process of *interpretive flexibility* was time consuming, and was further exacerbated by new social groups that had been formed (cross-functional project teams), which had to then create new *shared meanings*. Respondents recognized that *closure* was provided by reaching the end of a structured process, the formalism of declaring goals, or the development of a new piece of software. They also accepted that solutions could be either arbitrary in nature, or constrained by project resources that limited iteration before some acceptable solution had to be declared (described by Simon (1996) as satisficing). *Design flexibility* was also noted, for instance in different meanings attributed to the concept of commodity by engineering and purchasing. Lastly, *Problems and Conflicts* were different across different social groups. Engineering believed they were being pushed to declare non-existent/non-meaningful cost information, while finance saw engineers as irresponsible or untrustworthy because they mismanaged cost information.

Mindset

In general, our findings confirmed those of Gollwitzer & Moskowitz (1996), who observed that "the impact of appropriate mindsets on goal pursuit in key areas such as goal setting and implementation is positive to goal attainment." Respondents noted the effect of the "Not Invented Here" syndrome, a result of bringing together multiple functional

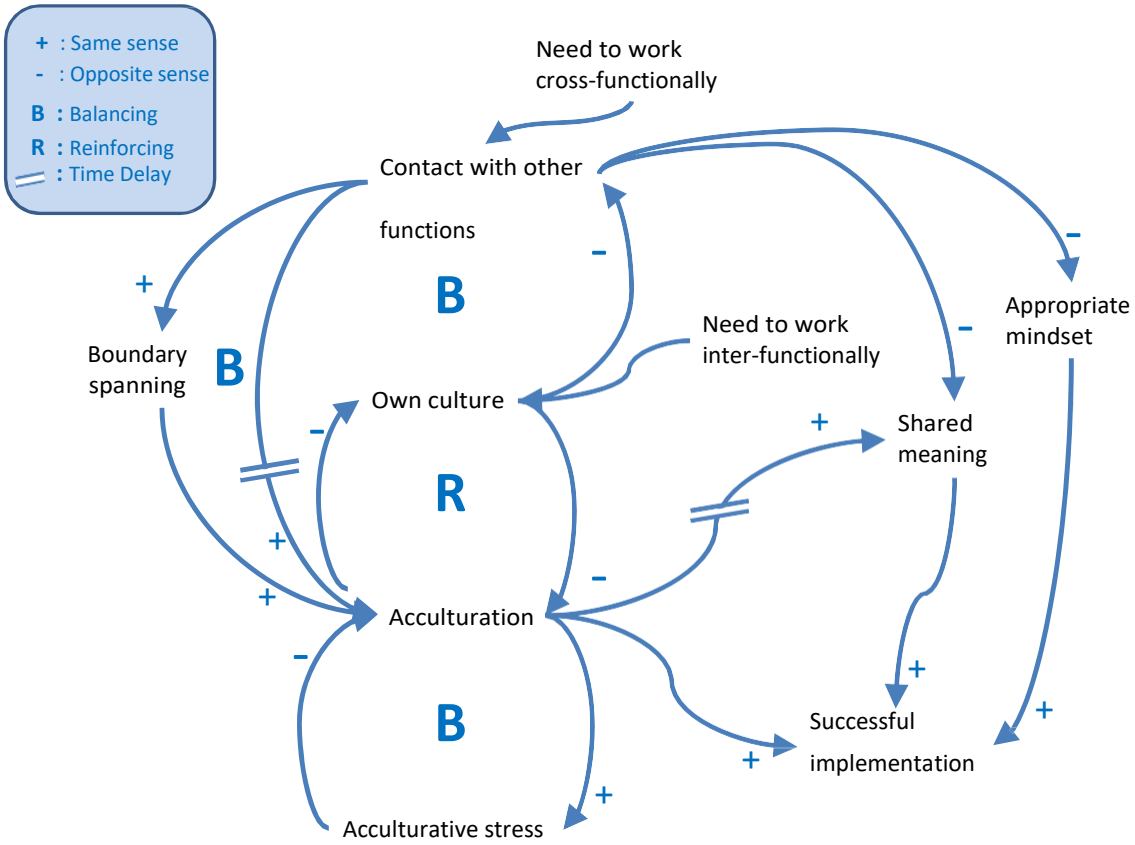
(cultural) groups, each of which tended to reject the ideas of the other. The result was a slowing of the development of goals, and in some cases selection of inappropriate goals. Respondents also described a number of tactics employed, some tacitly by functional organizations, to elicit desired behaviors by engendering specific mindsets in team members. For instance, a tactic of providing limited funding (significantly less than had been asked for) provoked a finance team to behave as though it was in an implementation phase at the planning stages. This caused team members to be focused and implementation driven, to strive for what was achievable in the short term rather than the perfect solution, and to iterate to a better solution over time. Similarly, an IT team of "non-purists" (developers who were open to technical alternatives) sharing an implementation focused mindset, rapidly achieved an excellent solution by processing implementation information about what could be achieved, rather than looking for the ultimate solution. Respondents from the finance function identified with a conservative planning mindset that was not overly optimistic. Generally, they would select attainable goals, leading to successful outcomes, and iterate towards some grander vision, demonstrating willingness to trade off speed against risk. The use of these tactics was sometimes tacit, reflecting characteristics of a functional culture such as finance, which tended to be conservative or risk-averse. Sometimes mindsets were the result of happenstance, such as the reduced funding of the finance project which was purely the result of corporate performance. In other cases overt efforts were used to drive certain mindsets, such as the selection of members of an IT team that were highly pragmatic to encourage rapid results. It seems reasonable to believe that opportunities exist to align cross-functional team mindset.

Overall, our findings indicate that the goals chosen by teams are impacted – negatively or positively − by cognitive bias. Attitudes such as NIH and conservatism seem to slow down goal attainment, or result in reduced goals at the outset. Planning mindsets seem to anticipate required change, or adopt agile approaches and make implementation more successful. Some mindsets discouraged rational planning, such as sunk cost, dogma, or technical purism.

Interactions between Social Factors

Absent shared meanings, common language and compatible mindsets, how do cross-functional teams achieve interoperability? The causal loop model below (Figure 8) depicts a set of potential interactions around acculturation. The need to work cross-functionally results in contact with other functions, leading (albeit slowly) to acculturation. Acculturation causes acculturative stress, which tends to slow down or reduce the amount of acculturation taking place. Acculturation also causes a reduced level of contact with an individual's own culture. At the same time, the need to work within an individual's culture to develop and implement these systems causes a reduction in the rate of acculturation, as well as a reduction in the contact with other cultures. The presence of boundary spanners speeds up acculturation. Contact with other functions reduces the rate of developing shared meaning, as the pool of possible meanings is increased. When one functional group rejects the meaning of another functional group inappropriate mindsets can result (for example "Not Invented Here"). Acculturation, shared meaning and appropriate mindsets all lead to successful implementation.

FIGURE 8
Causal Loop Model



Observations

Based on these discussions we suggest that:

- Social factors including acculturation, social construction, and mindset - challenge an organization's capability to develop and operate interoperable enterprise-level information systems.

- Boundary spanners who are experienced in multiple functional cultures can mitigate potentially adverse affects of these social factors by effectively speeding up the rate of acculturation.

- Strategic use of boundary spanners and overt mindset enhancement to improve cross-functional team behavior pose opportunities for improving interoperable enterprise systems, but are not well understood by line management.

LIMITATIONS

There are some limitations specific to this study. The study focused on the development of Bill of Material systems in a single automotive manufacturer in the US Midwest. As a result some aspects of this study may only be relevant to this particular manufacturer in this field of study. The upside of this approach is that the range of business functions permit control for those functions, while still including sufficient people for comprehensive discussion of inhibiting and assisting factors.

The collection of data from each of the business functions relied on interviewee's recollection of events. We acknowledge that the effect of time on memory may have biased our findings. Results may also have been affected because the interviewer was known to some of the people interviewed, and had interacted with them in the past. As is common with an interpretative approach, the categorization and analysis of data depends heavily on the perspectives and understanding of the researcher. Peer coding of the data was used to limit researcher bias and assure independence of categorizations

IMPLICATIONS FOR PRACTICE AND FURTHER RESEARCH

This study was initiated to inform practitioners and researchers about social factors that might account for failure to deliver interoperable enterprise-class systems. The findings and discussions should be viewed as suggestive, but not conclusive evidence of the phenomena. Three implications are suggested. First, management should be aware that social factors (acculturation, social construction, and mindset affects on goal setting) may account for developmental and operational issues with enterprise-class system interoperability. Cross-functional team composition and skills should be considered early, and appropriate training put in place to minimize the effect of these social factors. Secondly, when as inevitably

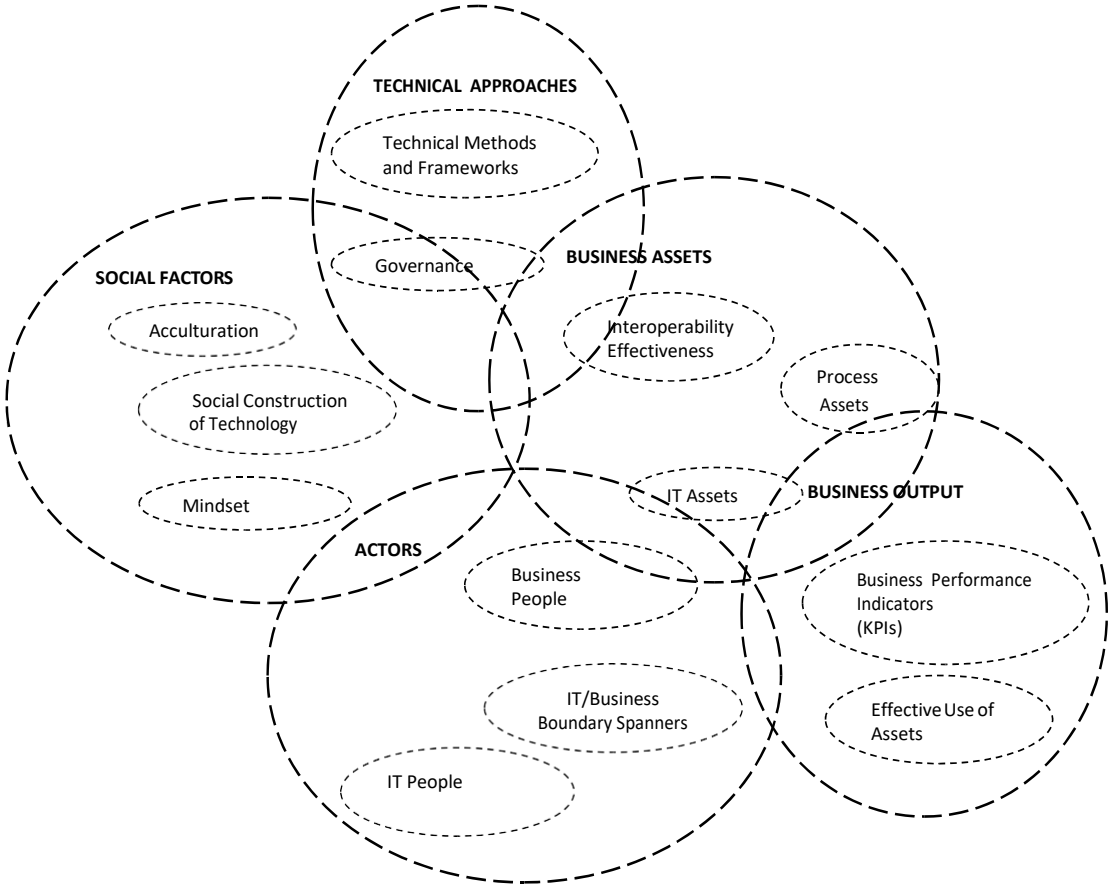
occurs, projects run into difficulties, social factors should be given prominence in the analysis and recommendations for improvement. Thirdly, as line management may be unaware of the potential for mitigation of interoperability issues using Boundary Spanners, development of a strategic approach to their development and use seems warranted.

The study suggests a number of areas for further exploration. First, replication of the research involving other firms in other industries would facilitate generalization of the findings. Secondly, more detailed longitudinal studies of the careers of Boundary Spanners could be undertaken to provide better methods for their development and retention. Thirdly, a simulation model could be developed facilitate to understand rates of acculturation, the role of boundary spanning, and potentially to investigate ways to speed the process of acculturation.

APPENDIX

The situational map suggests that the enterprise output is driven by actors, (representatives from such functions as engineering, manufacturing, finance, purchasing, logistics etc. and their IT counterparts as well as what we call "IT/business boundary spanners"). The actors use assets owned by the enterprise, which include processes, IT Tools, or information systems, and the capability for these to work together to support the endeavors of the enterprise. IT/Business Boundary Spanners are people from either IT groups with extensive business experience or business groups who typically oversee IT developments in their activities, and usually have extensive IT experience. The actors engage in the development and maintenance of the business assets, using methods and frameworks to ensure consistency, and governance models that ensure representation of the varied business groups and IT.

FIGURE A1
Situational Map



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THE MECHANISMS AND EFFECTS OF BOUNDARY SPANNING FOR ENTERPRISE-CLASS SYSTEM DEVELOPMENT PROJECT SUCCESS

By

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THE MECHANISMS AND EFFECTS OF BOUNDARY SPANNING FOR ENTERPRISE-CLASS SYSTEM DEVELOPMENT PROJECT SUCCESS

ABSTRACT

Information System Development (ISD) relies on cross-functional teams with distinct cultures and non-overlapping knowledge. Developing a shared understanding of the business needs and associated IS solutions by drawing upon these disparate knowledge sets is critical for project success. We extend theorizing regarding the mechanisms and effects of boundary on ISD success by exploring the relationships between acculturation, competence, and boundary spanning roles. We utilize survey data derived from 139 ISD projects in a global US automotive OEM, completed between 2006 and 2009. We show that the presence of boundary spanning roles, acculturative processes, and cross-domain knowledge and experience acquisition are significant factors positively affecting IS development success. We also demonstrate that facilitative boundary spanning roles- ambassador, coordinator, and scout- moderate the relationship between accumulated IS business domain knowledge and ISD success and that IS business competence is determined by acculturation among IS teams, and the technical competence of the IS team. This suggests that IS teams with low levels of business domain knowledge may be able to mitigate this deficit by exhibiting boundary spanning behaviors to enhance the flow of information across the knowledge boundaries.

Key words: Acculturation, Boundary Spanning roles; Competence; Confirmatory Factor Analysis; Exploratory Factor Analysis; Information System Development; Project Success; Quantitative; Structural Equation Modeling

INTRODUCTION

Developing enterprise-class Information Systems (IS) is a complex undertaking that relies heavily on cross-functional teams and knowledge (Cheney & Lyons, 1980; Sawyer, Guinan, Cooprider, 2008). These teams, often with a global reach, comprise business personnel, usually sourced from multiple functional units, who need to work together with IS personnel. The teams, by design, rarely have any members with completely overlapping knowledge sets, (Tesch, Sobol, Klein, & Jiang, 2009; Maruping, Venkatesh, & Agarwal, 2009). Furthermore, members come from different and distinct cultures, which tend to thicken the knowledge boundaries (Orlikowski, 2002). Yet, developing a shared understanding of the needs of the business and required IS solutions by sharing and integrating those disparate knowledge sets is at the same critical for information system development (ISD) success (Reich & Benbasat, 2000).

A good deal of has focused on the challenge of cross functional knowledge coordination by analyzing how distributed, cross-functional teams carry out successful projects (Blanton, Schambach, & Trimmer, 1998; Bassellier & Benbasat, 2004). These studies show that that paying attention to boundary spanning mechanisms that foster communication and knowledge coordination across knowledge boundaries directly affects project success. These spanning mechanisms can take multiple forms: (1) creating boundary spanning roles (Sawyer et al., 2008; Levina & Vaast, 2005); (2) increasing the IS competence of business personnel (Bassellier, Reich, & Benbasat, 2001; Bassellier, Benbasat, & Reich, 2003); (3) increasing the business competence of IS personnel (Bassellier & Benbasat, 2004); and (4) improving the acculturation of IS personnel into the business domain (Korzenny & Abravanel, 1998). While previous research has addressed the impact of several of these

mechanisms separately for their effects on specific outcomes like IT-business relationships (Bassellier et al., 2001; Bassellier et al., 2003; Bassellier & Benbasat, 2004; Sawyer et al., 2008), no research so far has addressed how different mechanisms relate to one another, and what are the impacts of these mechanisms on distinct project success dimensions (Espinosa, DeLone, & Lee, 2006).

To address this lacuna, we formulate in this study a theoretical model, which formulates specific relationships between boundary spanning mechanisms and elements of project success including budget and scheduling goals, and participant satisfaction. To validate the model we survey 154 enterprise-level ISD projects at a large North American automotive OEM including 399 sampling units (team members). Our findings indicate that boundary spanning affects significantly ISD success. This is exhibited both by the integrative as behaviors related to the presence if boundary spanning roles (Ancona & Caldwell, 1991), as well as by acculturation processes that promote domain knowledge and experience sharing between team members.

The remainder of the paper is organized as follows: first we review the relevant literature on boundary spanning and ISD project success. Then we present our theoretical model, detail hypotheses, and validate the model. We conclude with a discussion of the implications for practice and research.

REVIEW BOUNDARY SPANNING MECHANISMS AND ISD PROJECT SUCCESS

Enterprise-class ISD relies on identifying and integrating diverse business knowledge within a chosen business domain and integrating it with knowledge about appropriate IT solutions (Lyytinen, Rose, & Yoo, 2010). Thus successful ISD demands- in addition to mobilizing high level of IT knowledge and competence- intensive collaboration between IT

and business personnel (Cheney & Lyons, 1980; Sawyer et al., 2008). These groups participate in different communities-of-practice (Brown & Duguid, 1991; Bassellier et al., 2003) with distinct practices, knowledge bases, and language. Whilst IS personnel has highly specialized knowledge about the development and integration of IT, business people have hard-won knowledge about processes, practices and customers in their respective domains (Carlile, 2004). Thus, significant rifts typically abound across these bodies of knowledge, and it is a non-trivial task to span the boundaries and integrate this knowledge during ISD. Yet, the fact, that IS and business people can share and integrate this knowledge is perhaps the most important factor affecting project success (Reich & Benbasat, 2000). In order to do so, each group's knowledge perspectives must be rendered accessible to the other, just as those others must make an effort to internalize other's perspectives and integrate them (Boland & Tenkasi, 1995). This continual mutual adaptation of relevant knowledge during ISD has been coined as "boundary spanning" (Baroudi, 1985; Orlikowski, 1991), and it has been shown to affect positively ISD success (Maruping et al., 2009; Orlikowski, 2002) Next we review research that has addressed mechanisms that affect the process and outcomes of the boundary spanning during ISD. We also review research that links ISD success with the level of technical competence with ISD teams. We conclude with an analysis of project success construct.

Mechanisms of Boundary Spanning affecting ISD success

Extant research identifies two types of boundary spanning mechanisms: 1) creating *overlapping competencies* i.e. domains of knowledge between the IS personnel and the business personnel and 2) *generating integrative mechanisms* that enable the joint creation and sharing of the knowledge (Table 1).

The competency factors related to overlapping competencies can be roughly divided into *IS business competence* and *the Business IS competence* in the IS project context. Here, IS competence, comprises the knowledge and the experience that IS practitioners have at hand to design, implement, and maintain information systems (Pawlowski, 2004; Lyytinen et al., 2010). It covers dimensions of technical knowledge, communication knowledge and organizational knowledge. Here, the organizational knowledge comprises of *IS personnel's understanding of business*. This competence has been shown to positively affect the intention on the part of the business to re-engage with the IT people affecting directly project success (Bassellier & Benbasat, 2004). The increased importance of IS operations in business has also raised the need that business and functional managers must engage more strongly in IS projects in their functional area.

TABLE 1
Boundary Spanning Mechanisms

Role	Definition	Citation
Competence factors		
IS's business competence	The acquisition and possession of business knowledge and experience by IS people	Bassellier & Benbasat, 2004
Business's IS competence	The acquisition and possession of IS knowledge and experience by business people	Bassellier, Benbasat, & Reich, 2003
Integrative factors		
Knowledge flow management	Three key roles to manage knowledge flows across boundaries, Ambassador, Coordinator, and Scout.	Ancona & Caldwell, 1991; Sawyer, Guinan, & Cooprider, 2008
Acculturation	The properties of processes to exchanging cultural knowledge between two groups in face to face contact	Dohrenwend & Smith, 1982; Orlikowski, 2002

Another type of competence involves the *IS competence of business people*. As business personnel become more familiar with IS knowledge, they are more willing to participate, champion, and lead ISD projects and to partner with IS people in solving their business problems (Bassellier et al., 2001; Bassellier et al., 2003). This competence comprises both the IS knowledge and experience that business personnel have at hand to effectively partner IS personnel. It includes dimensions of technical knowledge, and some organizational knowledge related to managing and organizing ISD projects. The *business manager's IS competence* has been seen to influence the project success, as IS savvy business managers are more likely to assume effective leadership (Rockart, Earl, & Ross, 1996). In this context the higher levels of IS knowledge among business personnel provide the necessary means to identify and integrate meaningfully non-overlapping knowledge bases (Bassellier & Benbasat, 2003; Nelson & Cooprider, 1996).

Boundary spanning is also affected by the ways in which knowledge flows at the borders are organized and coordinated ,and how shared knowledge is built during day to day encounters between the IS people and the business personnel. In this sense effective boundary spanning requires also the creation and maintenance of *boundary spanning roles* within project teams that enable and foster cross functional knowledge coordination (Levina & Vaast, 2005; Sawyer et al., 2008). Ancona and Caldwell (1991) identify five boundary spanning roles: 1) ambassador, 2) coordinator, 3) scout, 4) guard, and 5) sentry. Boundary Spanners in these roles can 1) compensate for a lack of knowledge within the team by bringing that knowledge to the team from external sources, and 2) disseminate the knowledge in such a way as to bridge the existing knowledge gaps (Sawyer et al., 2008).

In this study we are in particular interested in roles that enable and foster knowledge flows within teams. These are: 1) ambassadors who operate by advocating for certain positions with internal and external groups. 2) Coordinators who ensure that information flows effectively between groups, and 3) Scouts who seek out knowledge from external sources and bring them to the team. Collectively, these three roles actively *facilitate effective* knowledge flows across the boundaries. Conversely, Guards *control* the release of information until the appropriate time, while Sentries protect the teams from external interference, allowing them to process information appropriately. We argue that these two roles will inhibit knowledge flow.

Finally, integrative mechanisms in boundary spanning involve the exchange of cultural features through firsthand contact between the IS and the business personnel (Kottak, 2005). We claim that expansion of a shared understanding requires that the team members communicate frequently across distinct organizational cultures (Orlikowski, 2002) inviting for constant alignment of language, values and beliefs. Here, culture is defined broadly as: "a set of cognitive and evaluative beliefs – beliefs about what is or what ought to be – that are shared by the members of a social system and transmitted to new members" (Miller-Loessi & Parker, 2006: 530), based on the work of House in 1981**.** These cultural features include not only cognitive beliefs, but also values and principles of language use, which both reflect an understanding of what is, and what should be (Miller-Loessi & Parker, 2006).

We surmise that how effectively IS personnel can acquire their business knowledge is likely to be affected by the acculturative process taking place prior and during the IS project. To this end we look at mechanisms that enable people to learn and understand "alien" culture of the business (or vice versa) by affecting the way in which the other culture is

rendered understandable through cues shared at face to face contacts. Thus, acculturation measures the extent to which the IS personnel is in regular contact with business representatives (and vice versa), and the extent and frequency of their social networking across borders. The approach adopted here in capturing the extent of acculturation within project teams draws on two streams of research. First we adopt an anthropological framework[1] developed by Korzenny & Abravanel (1998), which recognizes as drivers of aspects like language usage, exposure to the new culture, exposure to culture of origin, alignment with values of the new culture, and depth of interpersonal network in the new culture as elements of acculturation. In addition, we enhance the construct of acculturation with the dimension of Language Usage per Korzenny & Abravanel (Basso, 1967).

Technical Competence Affecting ISD Success

Several studies have observed that technological competence forms a significant antecedent for successful IS implementation (Blanton et al., 1998; Tesch et al., 2009). Technical competence is defined here as the ability to apply techniques and principles necessary to derive and document a sound IT solution- such as business data analysis, modularization, abstraction, or functional design- and a possession of specific organizational skills to coordinate design processes. Following Blanton et al. (1998) we include also interpersonal communication and leadership skills to this competence.

ISD Success

The project management literature defines Project Success as the extent to which the project meets its technical goals, remains within the budget, and is delivered in time (Jiang,

[1] In the past acculturation has been studied most in the context of national cultures, although other perspectives such as organizational or domain cultures have also been examined (Dohrenwend & Smith, 1962).

Klein, & Pick, 2003; Procaccino & Verner, 2006). In addition other streams of IS research include in the ISD success the idea of meeting higher level organizational goal such as improving operational efficiency or effectiveness (Procaccino & Verner, 2006). The last ones, however, are a somewhat difficult measure in the project context, as such measures are rarely agreed before ISD process, and many organizations lack the apparatus to measure such improvements (Sawyer et al., 2008).

In defining ISD success we draw on DeLone and McLean (1992) who reviewed over one hundred papers published between 1981 and 1988 dealing with IS success. After a careful review they posit that IS success comprises of six dimensions: 1) System Quality, 2) Information Quality, 3) Information/System Use, 4) User Satisfaction, 5) Individual Impact, and 6) Organizational Impact. Each dimension is viewed as an important and distinctive formative factor. In the similar vein, Saarinen (1996) argued that measures of investment effectiveness form a significant dimension of evaluating project success. He also notes the difficulty of operationalizing these measures and recommends using satisfaction with the development process as a surrogate.

We will apply DeLone and McLean's framework of success in evaluating the level of project success by reducing IS success construct into three constructs that are applicable in evaluating project outcomes (see Table 2): 1) system quality which reflects the technical system performance, accuracy, completeness etc., 2) satisfaction with system use, which represents the user's reactions to the system; and 3) satisfaction with the development process, which is seen as being a surrogate for a measure of investment effectiveness. These measures were selected for the following reasons. First, we are not interested to study individual users directly. Therefore, individual impact related to system use is not measured.

Second, we group system and information quality, into a single construct, System Quality as in practice most users have difficulty in separating them. Third, we adopt DeLone & McLean's (2003) suggestion that information/system use and user satisfaction, when applied to an environment where little choice of system use is afforded to the users, may not be a useful construct. This construct is thus better re-purposed to measure satisfaction with the system environment, such as system support, launch and training support, and IS department relationships. Third, we adopt Saarinen's recommendation to include a measure of investment effectiveness. To this end we include a measure of the Satisfaction with the Development Process. In contrast, we note that this can be seen as an intermediate measure, and can be excluded. DeLone and Mclean (2003) support his approach. Saarinen's conceptualization, is however somewhat vague as it includes measures of both IS competence and the development process. As we already investigate competence as an antecedent to project success, we refine his conceptualization only to cover satisfaction with the development process. This fits DeLone and McLean's original model better.

TABLE 2
Defined Dimensions of Project Success

System Quality	The required characteristics of the system that produces the information. Includes measures of performance, accuracy, reliability and completeness and the quality of the information such as its Accuracy, Completeness, Timeliness, and Meaningfulness
Satisfaction with System Use	Characteristics of the interaction of the user with the system, and by implication the information it manages. Includes measures of extent and nature of use.
User Satisfaction with the development processes	Represents the degree to which the business team is satisfied with the development process. Includes measures such as resource control, completeness of development, team member commitment.

Boundary Spanning and Project Success

Overall, we posit that project success is influenced by knowledge and skill and organizational factors that improve boundary spanning in project teams Figure 1). The antecedents of project success are therefore the level of acculturation by the IS members towards their business partners, IS personnel's technical and business competence, and the business personnel's IS competence (DeLone & McLean, 1992; Saarinen, 1996). The model posits that acculturation to the business by the IS members of the team, technical competence of IS members, and IS competence of business members are antecedents of system quality, satisfaction with system use, and development satisfaction. Accordingly we state the following relationships between the factors of acculturation, competence, and boundary spanning roles on project success dimensions, where the presence of boundary spanning roles is posited to moderate that impact of acculturation and business competence on quality and satisfaction (Figure 1). We will next articulate the hypotheses related to the impact of, acculturation, competence, and boundary spanning roles on IS project success. Related hypotheses are depicted in Figure 1.

Hypothesis Development

The impact of business and IT competence on system success. We posit after Blanton et al. (1998) and Bassellier & Benbasat (2004) that both the level of business and technical competence among IS members of the team influence positively system quality, satisfaction, and development satisfaction. Technical competence affects both the capability to determine requirements accurately and completely, and also the capability to implement systems with high quality. IS business competence affects the capability to link to critical

domains of business managers knowledge and to understand their needs and to probe them effectively. This will result in better requirements leading to higher system quality, satisfaction with system use and development satisfaction. We finally expect that aspects of IS competence exhibited by the business members of the team members influence positively System Quality, Satisfaction with System Use, and Development Satisfaction. This follows from the fact that based on better IS knowledge users can express their needs better, can set up more realistic expectations of the system and its performance, and also can be more satisfied with the development process. Therefore we hypothesize:

Hypothesis 1. IS Business Competence is positively related to System Quality, Satisfaction with System Use, and Development Satisfaction

Hypothesis 2. IS Technical Competence is positively related to System Quality, Satisfaction with System Use, and Development Satisfaction

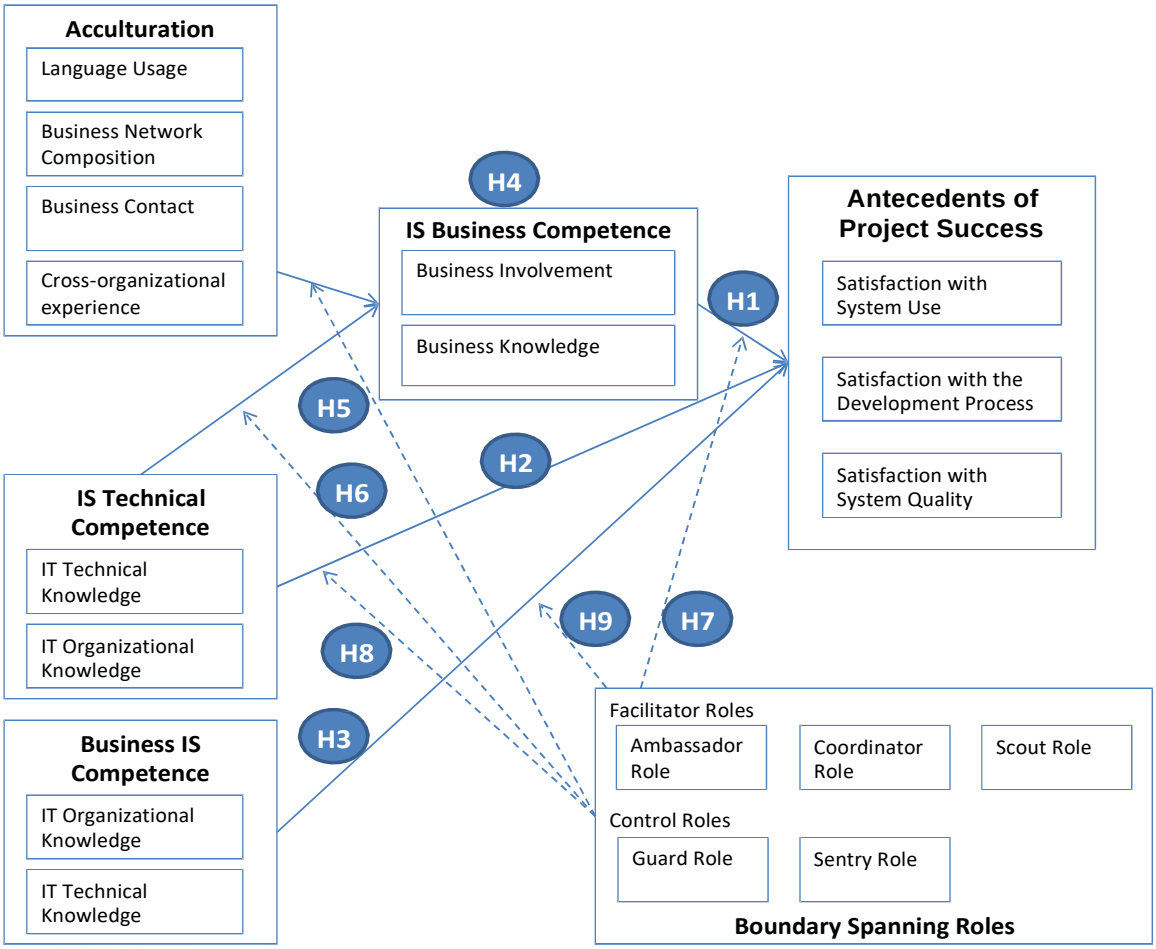
Hypothesis 3. Business' IS Competence is positively related to System Quality, Satisfaction with System Use, and Development Satisfaction.

The mediated impact of acculturation on system success. The source of business knowledge for the IS members of the team is either knowledge already acquired by them, or it originates from the business organization during the development project. If this happens during the project, it is highly dependent on the level of acculturation by the team members. Therefore, we posit a positive mediated relationship between acculturation and project success: i.e. business competence fully mediates the relationship between acculturation and ISD success. Thus, the influence of the elements of acculturation such as strength of contact and network, use of language, and experience help create the shared business knowledge, as represented by the IS business competence. We hypothesize that this competence dynamic is caused by the acculturative process, where individual level of acculturation improves due to

the increased scope and intensity of contacts with the business domain (Korzenny & Abravanel, 1998). Thus, we hypothesize:

> *Hypothesis 4. IS Business Competence fully mediates the positive effect of Acculturation on System Quality, Satisfaction with System Use, and Development Satisfaction.*

FIGURE 1
Causal Model of IS Project Success



Facilitating information flow through boundary spanning roles. Guinan, Cooprider, and Faraj (1998) report a positive impact of the presence of boundary spanning roles on ISD team performance. They do not, however, articulate the causal mechanisms that

boundary spanning roles play in affecting ISD success. We recommend, in line with our model in Figure 1, that boundary spanning roles either strengthen or weaken the impact of business competence and acculturation on project success i.e. the impact of the presence of cross functional knowledge and acculturation processes on ISD success moderated by differences in boundary spanning roles and related activities. Accordingly, when the levels of acculturation or competence are low we expect that boundary spanning roles act as an additional "boosting" mechanism that enables ISD teams to become successful, because of the increase in knowledge flow due to presence of effective boundary spanning roles. Thus, we would expect that cross-domain competencies would be more influential when those boundary spanning roles are not effective. In this case the knowledge situated in the teams, acquired either before or during the project through acculturative processes, would play a greater role. We accordingly hypothesize that:

> *Hypothesis 5. Effective Knowledge Flow through Facilitatory Boundary Spanning roles moderates the effect of Acculturation on IS Business Competence*
>
> *Hypothesis 6. Effective Knowledge Flow through Facilitatory Boundary Spanning roles moderates the effect of IS Technical Competence on IS Business Competence*
>
> *Hypothesis 7. Effective Knowledge Flow through Facilitatory Boundary Spanning roles moderates the effect of IS Business Competence on System Quality, Satisfaction with System Use, and Development Satisfaction*
>
> *Hypothesis 8. Effective Knowledge Flow through Facilitatory Boundary Spanning roles moderates the effect of IS Technical Competence System Quality, Satisfaction with System Use, and Development Satisfaction*
>
> *Hypothesis 9. Effective Knowledge Flow through Facilitatory Boundary Spanning roles moderates the effect of Business' IS Competence on System Quality, Satisfaction with System Use, and Development Satisfaction*

RESEARCH DESIGN AND METHOD

To validate the hypothesized model we conducted a survey on the impact of boundary spanning mechanisms on ISD success. The sampling unit was a project team while the data was probed from multiple team members including IS designers, business professional and sponsors. The survey examined the level of project success as the function of the presence of social factors including acculturation, competence, and boundary spanning among studied project teams. Similar topics have been investigated in the past, but never in the context of explaining ISD success (Tiegland & Wasko, 2003; Bassellier et al., 2003; Bassellier & Benbasat, 2004; Sawyer et al., 2008).

Measurement and Instrument Development

We operationalized model constructs as shown in Figure 1 by adapting existing scales where possible Table 3). All constructs and their scales are listed in Appendix A. Whenever existing scales were adapted we were careful to ensure that the items reflected the unit of analysis- the team. We followed the scale development procedures suggested by DeVellis (2003). After reviewing and modifying the item pool obtained from the literature review, we formed an expert panel of six researchers whose scales we had used, or who had been involved in similar research, and obtained their feedback in two rounds of reviews, five items were added as a result of these reviews All scales were defined as five point Likert-scales to alleviate some concerns of the effects of fatigue and to improve reliability. The questionnaire was somewhat lengthy with 121 items.

We used next a think aloud protocol with a sample of six IS practitioners to refine the questions and to ensure that they were comprehensible, accurate, and offered a basis for judgments (Bolton & Bronkhorst, 1996). Based on these pre-tests three items were modified

for improved comprehension and recall. We next pilot tested the scales by obtaining a sample of 35 IS practitioners, who did not participate in the final survey. The analysis of data showed normality (Kolmogorov-Smirnov significance > 0.05), adequate dimensionality (Kaiser-Meyer-Olkin > 0.5, Bartlett < 0.05), and item reliability (Cronbach's Alpha > 0.6) for all constructs. Factor analysis based on theoretical groupings demonstrated communalities above 0.3 for all, but four items. We did not make any changes to the survey as a result of the pilot test.

TABLE 3
Research Constructs and Their Respondents

CONSTRUCT	ITEM GROUPS	RESPONDENTS
Acculturation	Language Usage (LU) Business Network Composition (BN) Business Contact (BC) Cross-organizational Experience (CE)	IS Team Members
IS Business Competence	Business Involvement (OV) Business Knowledge (GU)	IS Team Members
IS Technical Competence	IS Technical Knowledge (TK) IS Organizational Knowledge (OK)	IS Team Members
Business IS Competence	Business's IS Organizational Knowledge (BO) Business's IS Technical Knowledge (BT)	IS Team Members Business managers
Boundary Spanning	Facilitator Roles Ambassador Role (AM) Coordinator Role (CR) Sentry Role (SN) Control Roles Guard Role (GR) Scout Role (ST)	IS Team Members
Project Success	Development Process (DP) System Use (SU) System Quality (SQ)	IS Team Members Sponsors Business managers
Control and Categorical Variables	Project Scope (PS) Project Type (NP) Nature of Innovation (PR) Business Domain (PD)	IS Team Members

Operationalization of Constructs

Dependent variable: Project Success. We used the instrument by Saarinen (1996), which is based on the widely used UIS instrument (Ives, Olson, & Baroudi, 1983).

Independent Variables

Acculturation. We used two primary sources for instrument items: Korzenny & Abravanel (1998) and Bassellier and Benbasat (2004). The inclusion of Language Usage is based on Basso's instrument (1967) research.

Competence

The scales to measure IS Business Competence were derived from Bassellier and Benbasat (2004). We used Blanton et al. (1998) instrument to measure technical and organizational skills of IS members of the team.

Moderating Variables

Boundary spanning roles. We used Sawyer et al.'s (2008) extended instrument of Ancona and Caldwell's instrument of five boundary roles. Only the three facilitator roles were found to be a significant moderator, and were included for further analysis. These were Ambassador, Scout, and Coordinator.

Control Variables

Scope and size. We controlled for differences due to the scope and size of the project. We measured project size with several indicators: project cost, development team size, business implementation team size, and project duration. We also controlled for geographical span of the project. A project that had a global span vs. regional deployment could include a greater number of virtual meetings, and therefore team relationships and acculturation might be altered.

Project type. Therefore we controlled for four development categories: minor enhancement, through new development. We also controlled for the computing platform, ranging in the order of complexity, from mainframe through personal computers to distributed applications. Finally we controlled for the nature of the system which could range from transactional systems to system integrations. The heavy duty transactional systems that *run the business* would be the most complex, that analytical systems would be less complex, having to account only for information complexity, while that integration efforts would be the simplest as they mostly were limited to moving existing data from one place to another. The final control was the software source ranging from in-house development to commercial packages.

Innovation/risk. Our final control assessed the level of innovativeness (originality) and risk. We posit that the level of innovativeness affects the level of competence required to successfully complete the project. We measured the level of business process innovation and the level of technology innovation separately on a five point scale, from breakthrough to no change. We then computed a formative index from both items to represent the level of innovativeness in each project.

Data Collection

The sampling unit in this study was a development team. The data was collected from multiple participants (data unit) of development teams in a major North American Automotive OEM. Respondents were identified and selected on the basis of their recent participation in development teams within the last three years. Thus some projects might have been completed up to two years prior to being surveyed. Initially, 256 teams were identified for sampling using the corporate project database, which listed the project, the e-

mail address of the project leader, the key project dates, and a limited amount of project data, such as budget, development scale, and platform. These projects had required in excess of 500 hours of development effort; we considered 500 hours to be a minimum threshold for project size as to ensure that there was an adequate team structure in place. Next, 181 projects were selected based on the access to the project lead (in other projects the lead had left the company and were not accessible for response)[2].

TABLE 4
Sample Demographics

Resonding/Non Responding Teams		Functional Organization	%	Scale	%	Hours	%	New/ Enhancement	%	Infrastructure Architecture	%
Responded	154 (86%)	Product/Process Creation	31.3	1	60.4	>100	54.2	New	40.7	Mainframe	30.0
		Manufacturing	2.8	2	31.3	>2000	16.7	Enhancement	59.3	Client-Server	26.4
		Logistics	9.0	3	8.3	>5000	16.7			Web Based	35.0
		Finance	11.1			>10000	7.6			Other	8.6
		Purchasing	4.9			>20000	2.1				
		Customer Service	14.6			>30000	2.8				
		Human Relations	13.2								
		Marketing & Sales	12.5								
		Information Technology	0.7								
Did Not Respond	27 (14%)	Product/Process Creation	30.8	1	69.2	>100	61.5	New	38.9	Mainframe	41.0
		Manufacturing	0.0	2	20.5	>2000	25.6	Enhancement	61.1	Client-Server	15.4
		Logistics	20.5	3	10.3	>5000	7.7			Web Based	33.3
		Finance	10.3			>10000	2.6			Other	10.3
		Purchasing	0.0			>20000	0.0				
		Customer Service	15.4			>30000	2.6				
		Human Relations	2.6								
		Marketing & Sales	20.5								
		Information Technology	0.0								

We identified three groups of respondents for different parts of the questionnaire per each sampling unit Table 3): 1) IS Members of the teams, i.e. IS professionals in the teams; 2) Sponsors, who controlled groups of projects, but were not involved with the teams; and 3) Business managers from the functional organization, who were responsible for providing overall direction and funding to the project, but were not involved on a day-to-day basis. IS team members were questioned for all constructs; business managers and sponsors rated

[2] The OEM went through a significant reduction in workforce including both IT department and business units and thus many participants were no longer reachable at the time of the study.

Project Success constructs. Additionally sponsors rated the IS competence of the business team members.

These project leads were asked to identify the business sponsor, the IS sponsor, and up to six participants on the team who met our qualification, which ensured that they would be able to provide complete and accurate data. The qualifications for the participants were that they should have been with the project throughout the development, and to have typically been in a position, where they would have a good overview of the project development, including the analytical work with the business partners. Most project leads identified their project managers, business analysts, solution architects, and account managers. In general, detail level team members such as programmers, database analysts etc. were not recommended by the project leads because of their lack of project overview. This was the expected response, and fits well with the technical skill survey questions. The qualifications for the IS and business sponsors were that the individual selected should have been involved in the project, and therefore in a position to assess the success of the project, but not involved in the day-to-day team activities, to provide some objectivity in the rating.

Data was collected over a twelve week period. Team members of the selected projects were made aware that the purpose of the study was to understand the impact of social factors on project outcomes. They were directed via e-mail to an internal, secure web portal where they were able to participate in the study. All responses were treated confidentially and respondents were assured that there would be no consequences for failure to respond. We kept track or respondents throughout the process, and issues two sets of follow-up e-mails to non-respondents throughout the process. Additionally we followed up with project leads to ask them to also remind their team members to complete the surveys. Overall 154 teams

provided usable data resulting in an effective project level response rate of 86%. Overall 400 surveys were completed from these 154 teams with the following response rate: 275 (73% response) from IS team members, 73 (40% response) from IS sponsors, and 52 (28% response) from Business Sponsors. Sample demographics for the data are shown in Table 4.They demonstrate a good spread of sampled projects. Non-response bias threat was considered to be acceptable based on the similar demographics of the sampled and non-sampled teams, and the high rate of project level response (86%). No statistical differences were observed between the population sampled, and the population that responded. The sample data was analyzed using t-tests (Table 5). No significant differences at the p=0.05 level were seen in the results of both early and late respondents nor with older or recent projects (those started in the first eighteen months of the cycle, and those started in the last eighteen months).

The responses were next aggregated first by each type of respondent; mean scores were calculated for each item for each construct at a team level from the IS team members. Then the mean score at the team level of the IS team members and the business sponsors was calculated for the business IS competence constructs, and then the mean score at the team level of the IS team members, the sponsors and the business managers was calculated for the success constructs. This was accomplished by using spreadsheet pivot tables and consistent project naming conventions throughout the survey solicitations and survey analysis routines.

Missing sponsor data values were imputed from the project level aggregated team data. The imputation for the sponsor used the IS team values plus the average mean factor difference, which varied between 0.17 and 0.24. The imputation for the Sponsor used the team data with no adjustment. A paired t-test of each factor was conducted to validate this

approach by setting alpha=0.05. To further validate the data imputation for the missing values we assessed the invariance of the structural model to the data from the IS teams, and both sponsor groups (Fornell & Larcker, 1981). The results shown in Table 5 confirmed that the differences were insignificant.

TABLE 5
T-Test of Old and Recent Projects

Factor	Sig.	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the	
						Lower	Upper
Accult	0.443149	0.193779	152	0.846608	0.014108	-0.12973	0.157946
ISComp	0.932303	0.947883	152	0.344693	0.057855	-0.06273	0.178442
BusComp	0.4213	1.959465	152	0.051888	0.144871	-0.0012	0.290942
ProjSucc	0.803898	1.530736	152	0.127913	0.101245	-0.02943	0.231921
BoundSpan	0.756514	0.703134	152	0.483048	0.037865	-0.06853	0.144258

TABLE 6
Invariance Test Results to Support Missing Value Imputation

	chi		DF		
	const	unconst	const	unconst	p
IS Sponsor - Bus Sponsor	813.3	773.6	340	327	0.000154
Bus Sponsor - ISSponsor	807.4	773.6	340	327	0.001291
IS Team - IS Sponsor	791.7	773.6	340	327	0.153759

Statistical Analysis

Data cleaning and measurement model. The data was screened by visual assessment; missing values had been excluded as part of the on-line survey process. Surveys were assessed for flat lining, and removed where necessary. The data was checked for normality, multicollinearity, homoscedascity, and univariate and multivariate outliers were removed. Overall, of the data for 154 project teams, 139 sets of acceptable data were used for final analysis.

The measurement models were constructed using both the aggregated and the non-aggregated data. The large number of items and the use aggregated values at the team level required that measurement models were developed for each factor, Acculturation, IS Competence, Business Competence, Boundary Spanning, and Project Success, separately. For the non-aggregated data we could build larger models, one for all the independent variables, and one for the dependent variables. Both approaches provided results that were not significantly different, yet allowed for some triangulation to validate the EFA.

Exploratory Factor Analysis (EFA) was conducted on the sampled maximal data set for each construct with principal axis factoring using Promax rotation with KMO > 0.5 and Bartlett < 0.05 for the data (see Appendix C). Given the sample size of 275 (n=IS members of teams) responses and the large number of items (121) EFA was conducted first for the Independent variables of IS Competence and Acculturation, then for Business IS Competence (n=326), and then for the Dependent Variables (n=399). The EFA results demonstrated appropriate loading (>0.6), communalities (>0.4) and cross-loadings (<0.3) for the proposed factor structure and to yield the final item set. The number of final factors suggested was seven in line with the theoretically defined constructs with Eigenvalues > 1.0, and the shape of a Scree plot suggesting seven factors. The final seven factors had acceptable reliability with Cronbach's Alpha > 0.6 (Appendix C). Items dropped during the EFA are listed in Appendix A, marked as *E.

We carried out Confirmatory Factor Analysis, CFA to validate the initial factor s structure. The CFA was conducted using both non-aggregated and aggregated data at the team level. The non-aggregated data provided a larger sample, which permitted larger measurement models to be built. These results were then confirmed with the aggregated data

on smaller sections of the overall model. The resulting factor loadings are shown in Table 8 and confirm the theorized construct structure. The factors have high loading all above the acceptable level 0.5 (Hulland, 1999) with no significant cross loadings. The overall fit of the two measurement models was reasonable, given the sample size and model complexity; modification indices were checked, and error-covariances added where they were theoretically justified (Byrne, 2001): Dependent Variable, CMIN/DF = 1.92, RMR = 0.013, CFI = 0.962, RMSEA = 0.083, (90% CI = 0.56 - .108), P CLOSE =0.023; Independent Variable, CMIN/DF = 3.1, RMSEA = 0.088, RMR = 0.045, CFI = 0.821, (90% CI = 0.83 - .094) P CLOSE =0.0.

The reliability (composite reliability (CR) > 0.7) and convergent validity with AVE > 0.5 were good (Table 7) (Fornell & Larcker, 1981). For discriminant validity we show that for all constructs the maximum shared variance (MSV) and average shared variance (ASV) are less than AVE (Fornell & Larcker, 1981). Common method bias, while not expected to be a threat given the multi-source nature of the data, was assessed using the common marker approach (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). It was found to be less than 0.1%. Items dropped during the CFA are shown in Appendix A, marked as *C.

TABLE 7
Construct Validity

Item	Std Loading					Item	Std Loading				
Language Usage		CR	AVE	MSV	ASV	Business Network		CR	AVE	MSV	ASV
1	0.82	0.86	0.67	0.46	0.34	1	0.56	0.65	0.49	0.45	0.36
2	0.90					2	0.82				
3	0.72										
Business Contact						Cross-functional Experience					
1	0.74	0.73	0.47	0.46	0.30	1	0.61	0.84	0.51	0.46	0.36
2	0.62					2	0.77				
3	0.69					3	0.69				
						4	0.79				
						5	0.71				
Business Involvement						Business Knowledge					
1	0.91	0.84	0.65	0.45	0.33	1	0.68	0.74	0.49	0.50	0.41
2	0.83					2	0.77				
3	0.66					3	0.65				
IS Tech Knowledge						IS Organizational Knowledge					
1	0.75	0.91	0.57	0.48	0.28	1	0.71	0.72	0.46	0.48	0.39
2	0.96					2	0.72				
3	0.68					3	0.60				
4	0.70										
5	0.64										
6	0.84										
Business IS Tech Know						Business IS Org Know					
1	0.75	0.71	0.56	0.49	0.49	1	0.71	0.65	0.48	0.48	0.34
2	0.74					2	0.68				
Faciliative Bound Span						Control Bound Span					
1	0.93	0.85	0.67	0.44	0.44	1	0.85	0.73	0.58	0.44	0.44
2	0.91					2	0.66				
3	0.55										
Development Process						System Use					
1	0.91	0.81	0.59	0.56	0.45	1	0.68	0.82	0.60	0.55	0.48
2	0.69					2	0.79				
3	0.69					3	0.85				
System Quality											
1	0.74	0.96	0.69	0.41	0.41						
2	0.77										
3	0.79										
4	0.82										
5	0.94										
6	0.83										

Hypothesis Testing

The seven factors were next used to construct the structural model to test hypotheses H1-H9. It separated between the constructs of Project Success, System Quality, Development Process, and System Use, which were introduced into the model as first order dependent factors. We used this model to test for the presence of the hypothesized direct, mediation, and moderation effects. We evaluated moderation (H5-H9) using both interaction terms and multi-group analysis. Mediation hypotheses (H4) were tested following Baron and Kenny (1986) test. Following Preacher and Hayes, (2004) we carried out bootstrapping test to confirm the significance of the observed mediation effects. Controls were added to the model using the variables Project Scope, Project Type, and Innovation Levels. The final structural model is shown in Figure 2, while the detected significant effects are listed in Table 8, and the bootstrap results are illustrated in Table 9. The overall fit of the structural model was good, CMIN/DF = 1.67, CFI = 0.962, RMSEA = 0.071, RMR = 0.044, (90% CI = 0.35 - .103) P CLOSE =0.146.

FIGURE 2
Structural Model

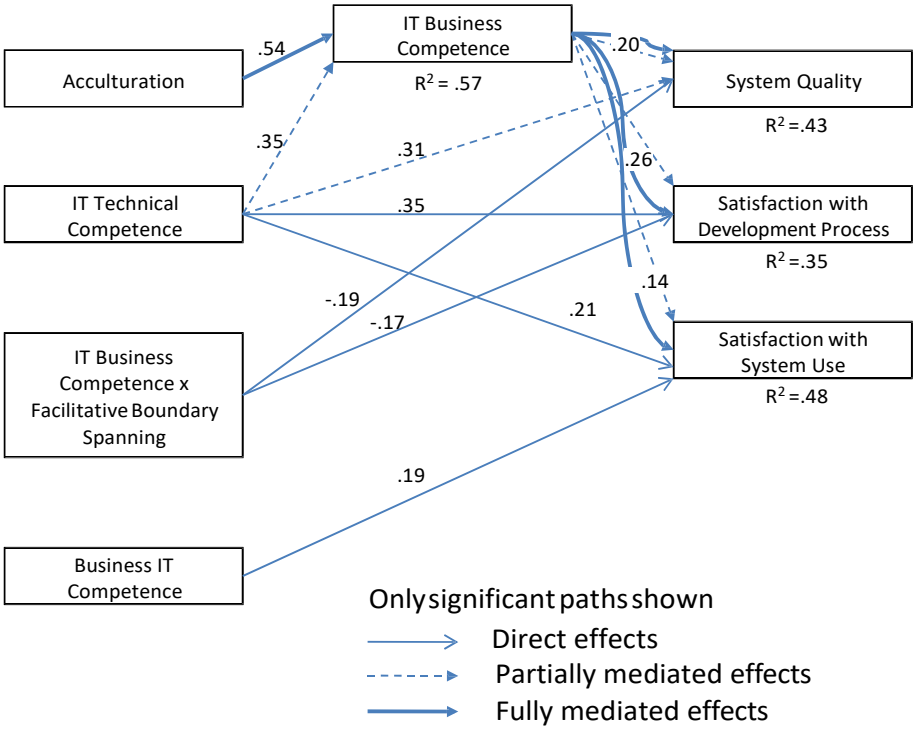


TABLE 8
Regression Results for Hypothesized Relationships

Construct Relationship			Estimate	t-statistic	P	R^2
ISBus	<---	Accult	0.541	8.73	***	0.69
ISBus	<---	ISTech	0.349	5.63	***	0.57
DP	<---	ISBus	0.263	3.93	***	0.53
SQ	<---	ISBus	0.199	2.37	0.018	0.43
SU	<---	ISBus	0.136	1.85	0.064	0.48
DP	<---	ISTech	0.35	4.40	***	0.56
SQ	<---	ISTech	0.305	3.64	***	0.49
SU	<---	ISTech	0.211	2.74	0.031	0.45
SU	<---	BusComp	0.193	2.96	0.003	0.41
DP	<---	ISBus x BSF	-0.19	-2.95	0.003	
SQ	<---	ISBus x BSF	-0.174	-2.86	0.004	
Controls						
SU	<---	PSize	-0.134	-2.04	0.042	
SU	<---	ProjType	-0.156	-2.12	0.034	
DP	<---	InfrArch	-0.149	-2.10	0.036	
DP	<---	Innov	-0.173	-2.26	0.024	
SQ	<---	Innov	-0.176	-2.176	0.03	

TABLE 9
Mediation Tests

Acculturation to System Quality > **Full Mediation**					
Factor	Effect	SE	Sig	CILow	CI Hi
Direct	0.05	0.095	0.609	-0.105	0.207
Indirect	0.115	0.062	0.071	0.012	0.216
Total	0.165	0.077	0.027	0.042	0.297
Acculturation to Satisfaction with Development Process > **Full Mediation**					
Factor	Effect	SE	Sig	CILow	CI Hi
Direct	0.005	0.086	0.944	-0.142	0.141
Indirect	0.168	0.059	0.003	0.06	0.272
Total	0.174	0.071	0.016	0.06	0.298
Acculturation to Satisfaction with System Use > **Full Mediation**					
Factor	Effect	SE	Sig	CILow	CI Hi
Direct	0.033	0.096	0.717	-0.122	0.19
Indirect	0.209	0.059	0.001	0.113	0.313
Total	0.242	0.076	0.001	0.118	0.366
IS Tech to Satisfaction with Development Process > **Partial Mediation**					
Factor	Effect	SE	Sig	CILow	CI Hi
Direct	0.276	0.078	0.001	0.149	0.405
Indirect	0.11	0.036	0.001	0.059	0.181
Total	0.386	0.07	0.001	0.269	0.501
IS Tech to System Quality > **Partial Mediation**					
Factor	Effect	SE	Sig	CILow	CI Hi
Direct	0.237	0.083	0.003	0.103	0.378
Indirect	0.074	0.042	0.064	0.009	0.148
Total	0.312	0.075	0.001	0.185	0.43
IS Tech to Satisfaction with System Use > **Partial Mediation**					
Factor	Effect	SE	Sig	CILow	CI Hi
Direct	0.211	0.077	0.031	0.053	0.364
Indirect	0.104	0.037	0.001	0.052	0.176
Total	0.315	0.085	0.001	0.176	0.456

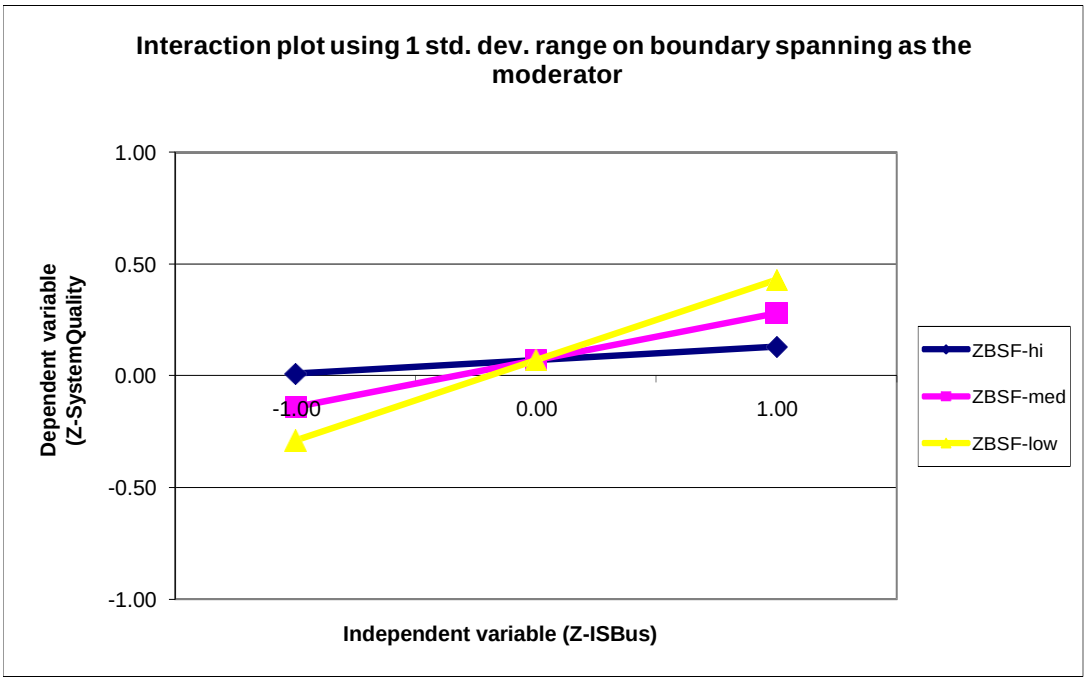
FINDINGS

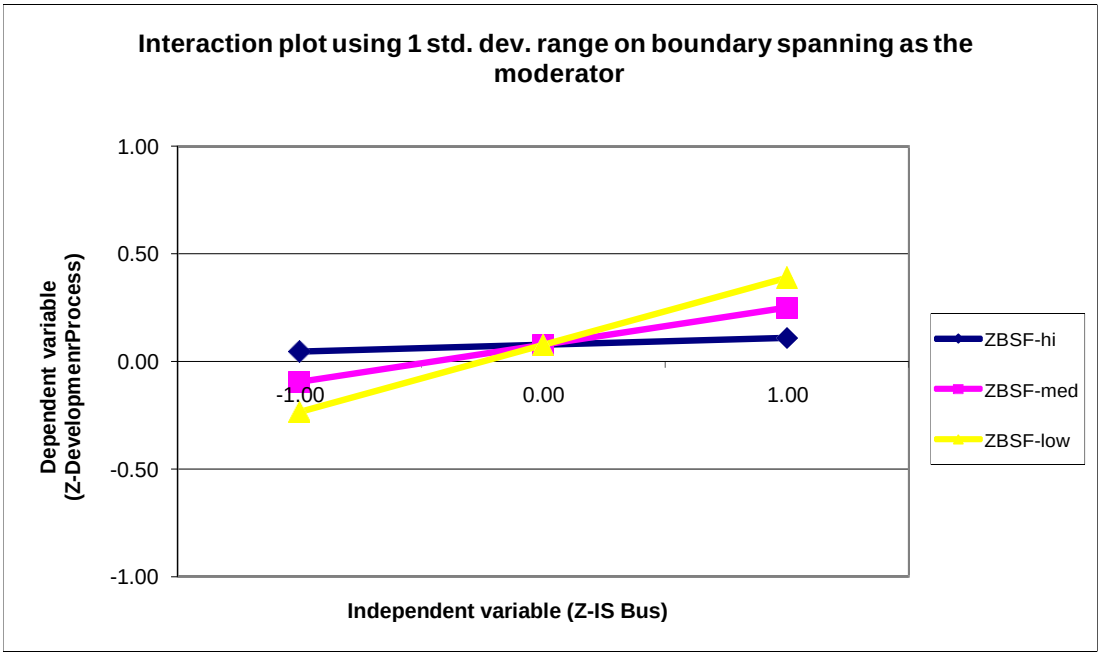
As hypothesized IS business competence **(**$\beta_{ITB.DP}$ =0.26 $p < 0.001$, $R^2 = 0.53$, $\beta_{ITB.SQ}$ =0.20 p = 0.018, $R^2 = 0.43$, $\beta_{ITB.SU}$ =0.14 p = 0.06 $R^2 = 0.48$,**)**, and IS technical competence **(**$\beta_{ITT.DP}$ =0.35 $p < 0.001$, $R^2 = 0.56$, $\beta_{ITT.SQ}$ =0.31 p = < 0.001, $R^2 = 0.49$, $\beta_{ITT.SU}$ =0.21 p = 0.03 $R^2 = 0.45$,**)** had significant positive influence on all antecedent aspects of project success

(**H1, H2 supported)**. We did not find significant impact of business IS competence on system quality, or on satisfaction with the development process (**H3 rejected)**. But we detected a significant positive impact on satisfaction with system use (**H3 partially supported** $\beta_{BC.SU}$ =0.19 p = 0.003 R^2 = 0.41,). We argue that this is likely the outcome of the IS competent business community to focus on those aspects of the system design that directly impact users. As hypothesized IS business competence was found to fully mediate the effect of acculturation on project success ($\beta_{ACC.DP}$ =0.17 p = 0.003, $\beta_{ACC.SQ}$ = 0.12 p = 0.071, $\beta_{ACC.SU}$ =0.21 p = 0.001) (**H4 supported)**.

For moderation effects we found that the interaction of IS technical competence and boundary spanning roles are negatively correlated with system quality, with a standardized effect of -0.12, at $p < 0.1$. However, a Chi-sq test for significance resulted in a $p > 0.05$, and this interaction is therefore not considered significant. The interaction of IS business competence and boundary spanning roles correlate negatively with system quality -.17, at $p < 0.05$, as well as having a further interaction with satisfaction with the development process of -0.19, at $p < 0.05$(a Chi-sq test $p < 0.05$). This interaction is graphed in figure 3 and was found to be significant. With increasing levels of facilitative boundary spanning, the influence of the domain knowledge of the IS personnel on system quality and satisfaction with the development process becomes less influential. This is in line with our hypothesis that cross-domain competencies will be more influential when the facilitative boundary spanning roles are not present. The controlling boundary spanning roles did not have any significant moderation effects as expected as they deal with knowledge flow from the team to the outside environment. **(H7 partially supported, H5, 6, 8, & 9 not supported).**

FIGURE 3
Interaction Effects of Moderator – Facilitative Boundary Spanning





Overall**,** our model explains 57% of the variance in IS Business Competence, 43% of the variance in System Quality, 35% in the Satisfaction with the Development Process, and 48% of the Satisfaction with system Use.

DISCUSSION AND CONCLUSIONS

Summary

This study is one of the first to explicitly link boundary spanning and acculturation processes with IS business competence, and examine the interplay between acculturation, IS technical competence, IS business competence, and ISD success. In this regard our findings offers new insights into management of IS development teams and their interfaces with business partners. We demonstrated that multiple boundary spanning roles are significant factors IS development teams, including those reported by Ancona and Caldwell (1991) that facilitated information flow (ambassador, coordinator, and scout), as well as acculturative processes, and cross-domain knowledge and experience acquisition. We found that IS business competence and IS technical competence did indeed have strong effects on project success. We further showed that IS business competence was determined by acculturation of IS teams with their business partners, and the technical competence of the IS teams; this reflects the desirability of high contact time between IS and the business. Finally, we demonstrated that facilitation boundary spanning roles, ambassador, coordinator, and scout, moderate the relationship of the accumulated IS business domain knowledge on project success. In practice, this implies that IS teams with low levels of domain knowledge may be able to mitigate this deficit by exhibiting strong boundary spanning behaviors to enhance the flow of information across the knowledge boundaries.

Discussion

Overall, our findings contribute to the literature in several ways. We extend theorizing about the role of IS business competence and its impact on project success. Prior research had included more limited measures of acculturation with IS business competence. We were now able to break these apart, and understand at more detailed level how acculturation drives the creation of business competence. We have further posited that IS technical competence plays a role in providing the IS practitioner with relevant skills to acquire this knowledge. Again, prior research has studied the role of IS business competence with regard to intentions of the business community to further engage their IS counterparts, but it has not to our knowledge been identified as a significant antecedent for project success. Another strength of this research is the larger sample of teams, which enabled us to test a more comprehensive set of knowledge based social factors affecting ISD success.

Practical Implications

The implications for practice are significant. They can be applied at all phases of the project life-cycle. We will enumerate them in therefore in a chronological order. We have demonstrated significant relationships between IS business competence and project success - in particular when the level of boundary spanning is low. Our primary implication then is for IS practicing managers to ensure that they build and maintain a steady supply of this valuable resource i.e. the IS professionals that are well versed in business knowledge. We also note that when boundary spanning is high, the value of business competent IS staff is less critical. This provides a second opportunity for IS managers; when staffing projects, if practitioners are not familiar with the business, then using staff members who are skilled in boundary spanning behaviors should be used to ensure that the requisite business knowledge can flow

across the organizational boundaries.

A second set of implications arise during the development process. Typical project management processes measure in-cycle project execution metrics, such as resource usage, meeting work product delivery dates, etc. to identify areas of risk. These are then addressed by a set of mitigating actions, and the project is kept under control. Few management techniques focus on measuring the social factors, and yet our research demonstrates that these explain significant variance in project success. We recommend then, that IS managers maintain in-process metrics that examine team competencies, and adjust these skills as necessary throughout the project execution. This might take the form of training sessions, interventions with business experts, use of techniques that improve knowledge sharing etc.

The final implications address the overall quality of the business relationships between IS and their business partners. Ongoing contacts between the IS practitioners and business representatives are essential to develop and maintain high levels of business knowledge. Outsourcing or off-shoring can be particularly detrimental to this process, as can high degrees of centralization of IS development. We recommend that IS managers evaluate which aspects of their software processes are sensitive to the impact of high degree of business knowledge and find appropriate counter-measures.

Limitations

We recognize limitations in our measurement of satisfaction with system use as users themselves were not sampled in the study. In contrast, their satisfaction was reported through third party: the IS team members, and the business and IS sponsors. We also recognize that the satisfaction with new capabilities is difficult to assess, as changes in the software, and user satisfaction over time is best captured through a longitudinal study. We examined

archival data on satisfaction held by the automotive OEM, but it was not sufficient to permit an independent assessment of the reported values. A further limitation to this work is that the data was collected from only a single enterprise. The decision to do this was made as we had an access to large number of software development teams and the desire to control for as many elements as possible to minimize the potential for confounding effects. Future studies, however, should seek to generalize these results with sampling in other populations.

Future Research

As mentioned, future research should seek to replicate this work in a number of environments to generalize the results. Governmental, Non-Profit, and Commercial sectors, together with an expansion of Industrial outside of Automotive would provide further validation. Expansion of the subjects interviewed to include direct users could provide further insight into the impact of the antecedents on organizational impact, as well as provide further insight into their impact on individual impact.

We also believe that further work is required in understanding the role of the acculturation processes on competence creation. Qualitative research (Fisk, 2009) suggests that competence is built over a period of several years. Yet, a better understanding is needed how this is effectively built, and deployed both during development projects, and in regular contacts between IS and their business partners. We did not distinguish specific IS roles during the research. Therefore further work is needed to identify which specific roles are most sensitive to business knowledge. One might assume that business analysts and designers are the most critical roles, and that programmers are less so, if enough business knowledge is captured in the requirements documents. However, as much of the business knowledge is tacit, and organizations engage in agile processes which blur the roles of IS

specialists. Therefore, further studies are warranted.

Our research focused on the influence of knowledge based factors on the elements of project success. We did not build a complete model of the project success factors, although we broadly noted DeLone and McLean's (2003) position. We believe that a further step that might be taken with the data collected is to further refine the relationships within that multi-dimensional construct.

One further area of research is to identify further factors that explain system quality when boundary spanning is high. In this case the social factors accounted for only about a third of the variance. We hypothesize that the direct contribution of business domain knowledge within the team accounts for that, but other factors should be assessed as well.

APPENDIX A
Table of Constructs

The following constructs are used in this report. Discarded items are marked with an asterisk.

Construct/ Dimensions	Definition	Items
Language Usage (LU) Korzenny & Abravanel (1998) Basso (1967)	The IS Team's familiarity with the technical language of the business Measured on 5 point Likert scale	Understanding of the jargon/technical language/acronyms /concepts of the business organization Use of the jargon/technical language/acronyms/concepts of the business organization Willingness to ask business colleagues to explain unfamiliar business terms The IS Team uses their own terminology for business constructs when not meeting with business team members or in internal documents*E
Business Network Composition (BN) Bassellier and Benbasat (2004)	The extent of the IS Team's Business Network Measured on 5 point Likert scale	Extent of social contact with members of the business organization* Extent of business contact with members of the business organization Extent of contact with the business organization's sub-groups*E Extent of access to members of business organization
Business Contact (BC) Bassellier and Benbasat (2004)	Measured on 5 point Likert scale	Extent to which the IS team takes actions to stay informed about developments related to the business organization Extent to which the IS team participates in business activities that are related to the business organization Extent to which the IS team is concerned about the overall performance of the business organization Extent to which the work of the IS team has impact on the performance of the business organization*E
Cross-organizational Experience (CE) Bassellier and Benbasat (2004)	Measured on 5 point Likert scale	Extent to which the IS team has extensive experience working with the business organization Extent to which the IS team understands the business organization's operating processes Extent to which the IS team understands this business organization's information standards Extent to which the IS team understands the connections and interdependencies between the sub-groups of this business organization.
Business Involvement (OV) Bassellier and Benbasat (2004)	Measured on 5 point Likert scale	Extent to which the IS team members are confident of being able to identify the correct contacts in the business organization Extent to which the IS team feels aligned to the primary mission of the business organization Extent to which the business organization's procedures make sense to the IS team*E

		Extent to which the IS team's values are similar to the business team's Extent to which the IS team understands the business organization's goals and objectives*E
Business Knowledge (GU) Bassellier and Benbasat (2004)	Measured on 5 point Likert scale	Extent to which the IS team members use knowledge of business organizations to make sense of information? Extent to which the IS team members display knowledge outside of their own organization Extent to which the IS team members have cross-functional experience*E Extent to which the IS team members have sufficient exposure to the business to understand how business requirements would be used in practice*C
IS Technical Knowledge (TK) Blanton, Schambach and Trimmer (1998)	Measured on 5 point Likert scale	The IS team's capability in standardized information gathering techniques*C The IS team's capability in standardized system development methodologies*E The IS team's capability in application architecture The IS team's capability in Information architecture The IS team's capability in human factors in system design The IS team 's capability in infrastructure architecture The IS team's capability in system security & controls architecture The IS team's capability in solution architecture
IS Organizational Knowledge (OK) Blanton, Schambach and Trimmer (1998)	Measured on 5 point Likert scale	The IS team's capability in software quality assurance techniques *E The IS team's capability in technical writing The IS team's capability in project management techniques The IS team's capability in persuasion and negotiation techniques The IS team's capability in interpersonal skills The IS team's capability in theories of organizational change and innovation The IS team's capability in formal presentation techniques* C
Business's IS Organizational Knowledge (BO) Bassellier and Benbasat (2003)	Measured on 5 point Likert scale	The business team's capability in system development life-cycle methodologies*C The business team's capability in acquisition of purchased software*C The business team's capability in project management practices The business team's knowledge of IS policies and strategies relating to their organization* The business team's knowledge of the IS vision for their organization The business team's understanding of the project charter*E
Business's IS Technical Knowledge (BT)	Measured on 5 point Likert scale	The business team's knowledge of information analysis methods*E The business team's knowledge of computer hardware in

Bassellier and Benbasat (2003)		general The business team's knowledge of computer software in general The business team knowledge about their own business IS applications *E The business team's knowledge about IS jargon *C The business team understanding of IS networks / communications concepts*C The business team's knowledge about personal computers*C
Ambassador Role (AM) Sawyer, Guinan, and Cooprider (2008)	Measured on 5 point Likert scale	IS team member's persuasiveness with other team members to support team decisions IS team member's persuasiveness with other team members that team activities are important IS team member's likelihood to resolve conflict within the team IS team member's likelihood to resolve design problems with external groups*C IS team member's likelihood to acquire resources (funding, people, equipment etc.) for the team*C IS team member's likelihood to report progress to higher levels in the company?*C
Scout Role (ST) Sawyer, Guinan, and Cooprider (2008)	Measured on 5 point Likert scale	IS team member's propensity to look for ideas from outside of the team IS team member's propensity to network with other peer groups to exchange information IS team member's success in identifying sources of required knowledge IS team member's direct interaction with members of external business organizations*E IS team member's direct interaction with members of the business team*C IS team member's direct interaction with members of the business team's organization*E IS team member's propensity to evaluate project support in the company*C
Guard Role (GR) Sawyer, Guinan, and Cooprider (2008)	Measured on 5 point Likert scale	IS team member's propensity to protect the team's image/product by avoiding the release of information IS team member's propensity to keep information about the team confidential until the appropriate time IS team members propensity to adopt defensive tactics to focus on their objectives IS team member's propensity to avoid discussions with external groups on topics not consensed within the team

Sentry Role (SN) Sawyer, Guinan, and Cooprider (2008)	Measured on 5 point Likert scale	IS team member's propensity to protect the team from external interference IS team member's propensity to protect the team from overload by external requests/information IS team member's propensity to absorb outside pressure to allow the team to work without interference*C IS team member's propensity to take action to minimize contact with other teams/organization IS team members propensity to avoid distraction and focus on their key objectives*C
Coordinator Role (CR) Sawyer, Guinan, and Cooprider (2008)	Measured on 5 point Likert scale	IS team members keep other teams/organizations updated on team activities*C IS team members coordinate activities with other teams/organizations*C IS team members publish or receive formal status reports, memos, data etc. IS team members interact with other teams to accomplish their objectives
Development Process (DP) Saarinen (1996)	Measured on 5 point Likert scale	The IS team is committed to ensuring a successful project*E The business team is committed to ensuring a successful project*E Requirement specifications is complete and accurate*E Analysis and design is complete and accurate Technical implementation is complete and is free of faults Budgetary control is maintained throughout the project lifecycle*C Timing control is maintained throughout the project lifecycle
System Use (SU) Saarinen (1996)	Measured on 5 point Likert scale	The business team is satisfied with the user training*E The IS team is satisfied with the content and frequency of communication with the users*E The business team is satisfied with the frequency and content of IS staff communications with users*E The IS – User relationship is positive The users responds well to system changes that were made The IS team responds well to new requirements from the business team
System Quality (SQ) Saarinen (1996)	Measured on 5 point Likert scale	The business team believes that system performance is acceptable* The business team believes that user response time is acceptable* The business team believes that ease of use is acceptable The business team believes that output accuracy is acceptable The business team believes that output reliability is acceptable The business team believes that the output is complete The business team believes that the output meets the user's needs The business team believes that output is clear and concise

Project Scope (PS)	1 – $10K – $1M 2 - $1 – 3M 3 – $3M – 5M 4 - $5 – 10M 5 – $10M+	Project cost ($)
	1 – 1 – 5 2 - 6 - 10 3– 9 – 15 4 - 16 - 20 5 – 21+	Size of development team (FTE)
	1 – 1 – 5 2 - 6 - 10 3 – 9 – 15 4 - 16 - 20 5 – 21+	Size of business implementation team (FTE)
	1 – 1 – 2 2 - 3– 5 3 – 6 – 8 4 - 9 – 11 5 – 12+	Project duration (Months)
	1 – Regional 2 - Global	Regional/Global
Project Type (NP)	1 – Maintenance 2 - Minor enhancement 3 - Major enhancement 4 – New development	Nature of development
	1 – Mainframe 2 - Client-Server 3 – Web-based 4 - PC based 5 – Other	Infrastructure Architecture
	1 – Transactional 2 – Analytical 3 – Mixed 4 - Integration 5 – Other	Nature of system
	1 – Proprietary development (in-house) 2 - Proprietary development (outsourced) 3 - Commercial Off-the-Shelf 4 – Commercial customized 5 - Other	Software source

Nature of Innovation (PR)	1 – Breakthrough 2 - Major change 3 – Moderate change 4 – Minor change 5 – No change	Business process innovation
	1 – Breakthrough 2 - Major change 3 – Moderate change 4 – Minor change 5 – No change	Technology innovation
Functional Domain (PD)	1 – Product/ Process Creation 2 –Manufacturing 3 – Manufacturing Planning and Logistics 4 – Finance 5 - Purchasing 6 – Service 7 – Human Relations 8 – Marketing and Sales 9 - Information Technology 10 - Other	Functional domain
	1 – Business 2 – IS – Process Technology Group 3 – IS Software Development 4 – IS Operations 5 - Other	IS organizational domain

APPENDIX B
Correlation Matrix of Latent Variables

Variables	Mean	SD	Accult	ITBus	ITTech	Bus Comp	BS Facil	Dev Proc	Sys Qual
Accult	3.97	0.41							
ITBus	4.05	0.41	-0.53						
ITTech	3.96	0.39	0.08	-0.26					
BusComp	3.63	0.49	-0.18	0.10	-0.27				
BSFacil	3.99	0.34	-0.06	-0.21	-0.25	0.00			
DP	4.18	0.42	-0.03	-0.14	-0.24	0.08	0.07		
SQ	4.27	0.41	-0.05	0.05	-0.09	-0.04	-0.20	-0.38	
SU	4.16	0.44	-0.03	-0.14	0.01	-0.24	0.05	-0.31	-0.19

Note: n = 136

APPENDIX C
Data Reliability

Construct	KMO	Bartlett	Factor	Cronbach Alpha
Acculturation	0.85	0.00	Language Usage	0.83
			Business Network	0.60
			Business Communication	0.70
IT Competence	0.89	0.00	Cross-functional Experience	0.83
			Organizational Values	0.83
			Business Knowledge	0.74
			IT Technical Knowledge	0.89
			IT Organizational Knowledge	0.70
Business IT Competence	0.81	0.00	Business Organizational Know	0.65
			Business Organizational Know	0.71
Project Success	0.77	0.00	System Quality	0.93
			System Use	0.82
			Development Process	0.78
			Organizational Impact	0.92
Boundary Spanning	0.91	0.00	Ambassador Role	0.73
			Scout Role	0.64
			Coordinator Role	0.73
			Guard Role	0.77
			Sentry Role	0.71

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