

THE SOCIOMATERIALITY OF BOUNDARY- SPANNING ENTERPRISE IS DESIGN

Completed Research Paper

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Abstract

The paper uses and extends upon a sociomaterial view of organizational IS by relating this to modalities of sensemaking across boundaries and levels of framing in managing the meaning of IS performativity. Data from a field study of Enterprise IS redesign at a US University are analyzed from an actor-network perspective to reveal a genealogy of IS design evolution. Three modalities of sociomaterial design - boundary objects, bridging operations and conscription devices – are examined at multiple levels of design-framing, to understand the emergence of enterprise IS redesign, its political alignment and associated business processes. The result is a conceptual framework which explains how the meanings attached to an enterprise IS emerges are temporally emergent in practice, demonstrating interactions between levels of sensemaking which create unexpected consequences for IS users and exposing backstage negotiations that enable the meaning of an IS design to be managed in practice.

Keywords: Sociomateriality, Boundary-spanning collaboration, Actor-network theory, Enterprise IS Design, Management of meaning, Boundary object

Introduction

The importance of design in the provision of organizational information systems (IS) has faded from view in academic research, as the focus of attention shifts upstream of the systems development lifecycle waterfall model. Recent studies of organizations have demonstrated that design continues through processes of user adaptation and improvisation, to provide the mutability required to support collaboration across and between communities of practice. Organizational IS are designed to support idealized, generic business processes, then evolve through use, to provide support for local practices (Levina and Vaast 2005; Markus et al. 2002). This leads to a fragmentation of IS-supported business processes across the enterprise, that must be periodically realigned with enterprise goals through the co-design of business and information technology (IT) systems. It is the concept of IS design as enterprise realignment that provides the focus of this study, as we attempt to understand IS design as a process of conceptualization that defines the role and purpose of information technologies across the enterprise.

A focus on IS design as enterprise realignment leads to the following research question: How does enterprise level IS design and business alignment unfold? How do organizational managers and representatives of diverse business groups transcend an existing set of fragmented, local knowledge and work-practices to produce an enterprise-level business process model? To understand IS design as enterprise realignment (i.e. the redefinition of IS role, purpose and form in managing the business enterprise) as opposed to IT systems design (i.e. the constrained design of IT systems that support organizational IS), this paper uses and extends upon a sociomaterial view of organizational IS (Orlikowski and Scott 2008) by relating this to multiple modalities of IS translation across boundaries and multiple levels of framing in managing the meaning of IS performativity in organizational systems of work. It contributes to the organizational design literature by developing a conceptual framework through which the emergence of enterprise IS design and its political alignment may be understood.

Groups of organizational change agents simultaneously inhabit intersecting social worlds – both as members of multiple communities of practice and also as negotiators across multiple competing interests in achieving change (Balogun and Jenkins 2003; Lave and Wenger 1991). This presents an inherent challenge to the coherence of enterprise IS design. The negotiation of enterprise IS goals, forms, and purpose across group frameworks for action cannot be understood from a single point of view. Instead, it requires an ecological analysis that reconciles competing interests and interpretations (Star and Griesemer 1989). Material artifacts (and by implication organizational realities) result from chains of relations - or genealogies - between social realities and material configurations. As various actors or groups contest, negotiate and define the role of technology objects in specific work-practices, the meaning of these objects is assembled and inscribed in an evolving information system definition. Over time, inscriptions take on a generic acceptance and the modalities and processes by which they occurred disappear from view, as do the technology objects (or apparatus) from which they derived (Latour 2005; Law 2004). The modalities and processes of boundary-spanning negotiation are therefore invisible - all we are left with after the fact are the vapor trails of IS design and rationale. To understand these modalities and processes, we must follow the genealogy of design.

The paper is organized as follows. First, we review and extend a sociomaterial perspective on organizational IS design, based on actor-network theory (Latour 2005; Law 2004) and our view of design as the *management of meaning*. Based on a reconceptualization of existing literature on boundary objects, we suggest three mediating roles, or modalities of material technology that enable design negotiation at the boundary between knowledge domains. We employ a multi-level framing perspective to account for the cross-level, systemic, and embedded effects that result from analyzing organizational interpretation as sensemaking (Drazin et al. 1999). Secondly, we present our empirical approach and the analysis of data from a longitudinal field study, to provide a genealogy of enterprise IS design over time. Thirdly, a synthesis of findings employs the multi-dimensional conceptual framework to trace how the meaning of the enterprise IS is managed by interactions across the actor-network involved in the design. The discussion section examines the significance of the temporally emergent processes and modalities involved in enterprise IS design, relating this back to research literature. Finally, we draw implications from our newly developed understanding for the design of enterprise IS in research and practice.

Theoretical Development: A Sociomaterial Perspective on Boundary Spanning IS Design

A sociomaterial perspective moves away from conceptualizing discrete entities of people and technology, to dissolving the analytical boundaries between technologies and humans. By viewing human agency and systems of technology as mutually constituted, we can appreciate the mechanisms required to disentangle these relations when change is needed. This paper explores the processes and modalities by which this occurs. A grounding in three key aspects of sociomaterial unfolding may afford conceptual innovations (Orlikowski and Scott 2008):

- *Sociomaterial Assemblages* – how accommodation is achieved by sociomaterial adaptations around the ways in which material objects scaffold social activity;
- *Material Relationality* – the ways in which frameworks for social action and material artifacts are mutually constituted and related;
- *Performativity* – the ways in which organizational reality is enacted by means of a particular discourse or frame that constitutes reality in a specific way.

To understand sociomaterial practice, we need to follow the entanglements between sociomaterial assemblages, relationality, and performativity that result in IS being conferred with specific meanings, roles, and forms. This framework will be used to structure the conceptual underpinnings of this analysis.

Actor-Network Theory As A Lens For Sociomaterial Assemblages

Actor-Network Theory (ANT) provides a ‘sociology of translation’ within which the assemblages of human and nonhuman actors that underlie sociomaterial relations can be understood (Latour 2005). A key concept of ANT is the idea of material artifacts as “non-human actors.” Human interests, assumptions, goals, and use-scenarios are embedded in the design artifacts – these constrain their use, to direct the activities of users after delivery. For example, office doors are designed with a closing-mechanism to prevent humans from leaving them ajar – it takes a great deal of ingenuity and effort to circumvent automatic door-closing mechanisms (Latour 1991). An actor-network perspective allows us to trace the evolution of sociomaterial assemblages, as agency is transferred from human to nonhuman actors and back again.

ANT provides a supersuming framework, that links together the concepts of epistemic alignment in networks of human and nonhuman actors, agency-as-script, objects and artifacts as the embodiment of agency, and the political pressures for of design irreversibility. As Law (1991) observes:

“the ‘social order’ is neither social nor an order ... Structures do not simply reside in the actions of people, or of memory traces. They exist in a network of heterogeneous material arrangements. ... heterogeneous engineers – agents, whether human or not – are constituted in the arrangement of these materials.” (Law 1991, pg. 16).

Sociomaterial assemblages are temporally emergent in practice (Pickering 1993). Organizational practices, structures, and worldviews (interpretative structures) emerge from the material overlaps between human and nonhuman action (Law 1991). Non-human objects act out a form of embodied agency, as they reflect the scripts, intentions, boundaries, and constraints-on-use of those who designed and configured them. But following this agency is difficult. Both human actors and nonhuman actors (objects) appear only intermittently in the genealogies of social order (Latour 2005). To make sense of the ‘vapor trails’ left behind by the interactions between human and non-human agency, we must understand the modalities by which the material technology object relates to different forms of agency and how sensemaking – the framing processes by which specific roles, constraints, boundaries, and meanings are attached to a technology apparatus – enables the IS to enact (or perform) a particular organizational reality (Knorr Cetina 2001; Orlikowski and Scott 2008; Weick 1995).

Modalities of Material Relationality

To understand the ways in which an IS embodies human relations and intentionality, one must follow the mediating mechanisms that enable stakeholders to relate social realities to material configurations. These modalities explain the processes by which boundaries between frameworks for social action (which Wagner et al. (2010) call “fields of practice” and Engeström et al. (1995) refer to as “participation frameworks”) are disrupted, enabled, or changed as a result of IS needs definition. Barad sees material relationality as political, arguing for “a causal relationship between specific exclusionary practices embodied as specific material configurations of the world (i.e., discursive practices/(con)figurations rather than “words”) and specific material phenomena (i.e., relations rather than “things”)” (Barad 2003, pg. 814). Other perspectives view material relationality as more negotiated, concerned with transferring, translating and transforming knowledge across practice boundaries (Carlile 2002) or reconciling situated practices by developing polycontextual frameworks for action (Engeström et al. 1995).

We therefore suggest three mediating roles – or modalities – of material technologies in facilitating the translation of social and organizational structures into joint frameworks for action that span community of practice boundaries:

- *Boundary objects* focus on the informational or knowledge ecology of practice. These reconcile or translate knowledge specific to each domain, so that an individual in one group can collaborate with individuals in another group without needing to understand their rationale (Star and Griesemer 1989). For example, a roadmap provides route information which does not require a motorist to understand the significance of all the geographical features marked on the map. Yet a cyclist may rely on information such as road-gradient to determine which route to take. Neither user needs to understand how the other uses the map in order to navigate their own route. But the inclusion of both types of information on the map demonstrates its negotiation over time at the boundary between different groups of users.
- *Bridging operations* reconcile situated practices across functional groups. They provide a framework for action that allow actors to make sense of practice across workgroups and so produce organizationally-accepted (a.k.a. “generically subjective”) knowledge that is understood by adopting practice-based routines that integrate workflows across organizational boundaries (Engeström et al. 1995; Weick 1995). For example, we need to determine which items are in stock in order to process a sales order and we need to determine the expected delivery time in order to predict the delivery date. We must therefore link current production status recording with sales order processing, and link sales order processing with delivery logistics – this is formalized through an inventory management and sales order processing IS that constantly relates the status of work of one group to the status of work in another, even though the production group is not concerned with sales totals and the sales group is not concerned with delivery logistics. The shared vocabulary of inventory management and delivery logistics provides an epistemic basis for making sense of these systems of practice – even from the outside, they retain a common meaning across contexts (Knorr Cetina 2001).
- *Conscription devices* align the interests of organizational actors around a specific representation of organizational or technological change (Henderson 1999). This modality of material relations emphasizes the exclusionary power of mediating objects in focusing attention on one aspect of social relations at the expense of others (Barad 2003). For example, representing communication channels by means of a formal organization structure chart emphasizes discontinuities between groups and directs people to use hierarchical reporting channels. Representing communication channels as a list of alternate communication mechanisms, such as shared discussion boards, chatrooms, Sharepoint groups, knowledge-sharing systems, and corporate library resources, encourages people to experiment with specific channels for more lateral communication between groups.

This research study examines the processes of IS definition to explore how each of these modalities facilitates the evolution of boundary-spanning IS.

Levels of Framing In Sociomaterial Performativity

An ecological view of sociomateriality in IS design entails an understanding of the sensemaking processes by which the meaning of an organizational IS – its goals, purpose and form – are managed across the various social worlds that reflect the operation of specific communities of practice - for example, a functional workgroup (Lave and Wenger 1991). Each community of practice embeds a frame of reference for the situation, that individuals absorb into the mental models, or cognitive frames that they use to make sense of how the world “works” (Goffman 1974). As organizational IS are defined, stakeholder frames – in the sense of scripts for action and assumptions about their relevance - are embodied in non-human actors, privileging specific contexts and types of use and excluding others (Akrich 1992). The material apparatus of an IS thus enacts particular scripts that direct and/or constrain human activity in a specific way, depending on the assumptional frameworks for action embedded in its design. For example, if I attempt to order Olympic UK cycling team merchandise from the USA, the UK team link takes me to the US cycling team page, assuming that I can only be interested in the team associated with my current internet domain location (the USA). This design frame constrains my use of the Olympic merchandise system by directing its performativity to follow a location-specific script.

In exploring how organizational realities are framed, studies of sociomaterial unfolding tend to conflate multiple levels of analysis. For example, empirical studies frequently assume that individual perspectives reported in interviews reflect group and organizational perspectives, or that consensus agreements reflect a shared understanding. This approach is problematic because it ignores the cross-level, systemic, and embedded effects that result from analyzing organizational interpretation as sensemaking (Drazin et al. 1999). We need to disentangle these levels of framing, if we are to understand the influences that underlie enterprise IS design. Weick (1995) defines three levels of framing in organizational sensemaking:

1. An intrasubjective (cognitive) level, that represents an individual, internal view of organizational reality;
2. An intersubjective level, that represents tacitly-shared frames of reference that are constructed through joint participation in a community of practice (CoP); and
3. A generically-subjective (collective) level that represents a commonly-accepted (consensus) view of organizational reality.

We propose a fourth level, the *extra-subjective*, that represents the enactment of organizational reality through the management of meaning. The success of an IS change project depends upon an ability to build “backstage negotiation spaces” that separate strategies for obtaining political support from strategies to mobilize support across the collaborating network of design participants (Law and Callon 1992). This form of influence is termed “extra-subjective” as it is usually exerted without the manager ever participating explicitly in the design initiative. In leading, managers generate a point of reference that indicates a particular strategy. By behaving in specific ways, or approving/disapproving of particular responses, strategic leaders manage the meaning of events and phenomena for others (Smircich and Morgan 1982). Organizational identity and power are developed via social networks which provide an interlocking system of roles and responsibilities. These may be transient, but align around specific political interests, reflecting webs of expertise and authority (Leonardi 2011). Managing the significance ascribed to one knowledge domain over others, for specific strategic initiatives provides managers with a tool to enact organizational reality for others (Balogun and Jenkins 2003). It is in this way that sociomaterial performativity is embedded in an organizational IS.

An Epistemological Framework For The Analysis of Sociomateriality

The previous sections have argued that IS innovations are not neutral as they reflect sociocultural frames at multiple levels of analysis that are shaped by – and in turn shape - interlocking assemblies of social organization and practice. Organizational information systems (IS) can therefore be conceptualized as both the product of this process – representing the sociomaterial assemblage resulting from negotiations around how to support organizational “reality” – and also the modalities of the process. It is in this mediating role that IS provide various boundary-objects-in-use (Levina and Vaast 2005). By analyzing IS primarily as boundary objects, which emphasizes collaboration and collective sensemaking, we may filter out mechanisms for reconciling competing or contradictory practices or aligning the interests of strategic

decision-makers (which may often be more ad hoc and short-term than strategic, as illustrated by the field study below) with the interests of strategic enterprise business process change. We therefore suggest the three modalities of IS change discussed above.

The epistemological lens for this analysis suggests a two-dimensional framework, illustrated in Figure 1. The dimension of *material relationality* adopts three modalities of IS evolution, based on the mediating roles of material devices in facilitating the translation across boundaries between social and organizational structures and joint (practice) frameworks for action, viewing the unfolding IS as boundary-object, bridging-mechanism, or conscription device. The dimension of *sociomaterial performativity* is based on four levels of framing that relate to the embodied management of design meaning for practice: individual (intrasubjective), group (intersubjective), organization (generically subjective), and strategic networks (extra-subjective). The research study that follows provides a genealogy of sociomaterial unfolding which employs this framework as the basis for analysis.

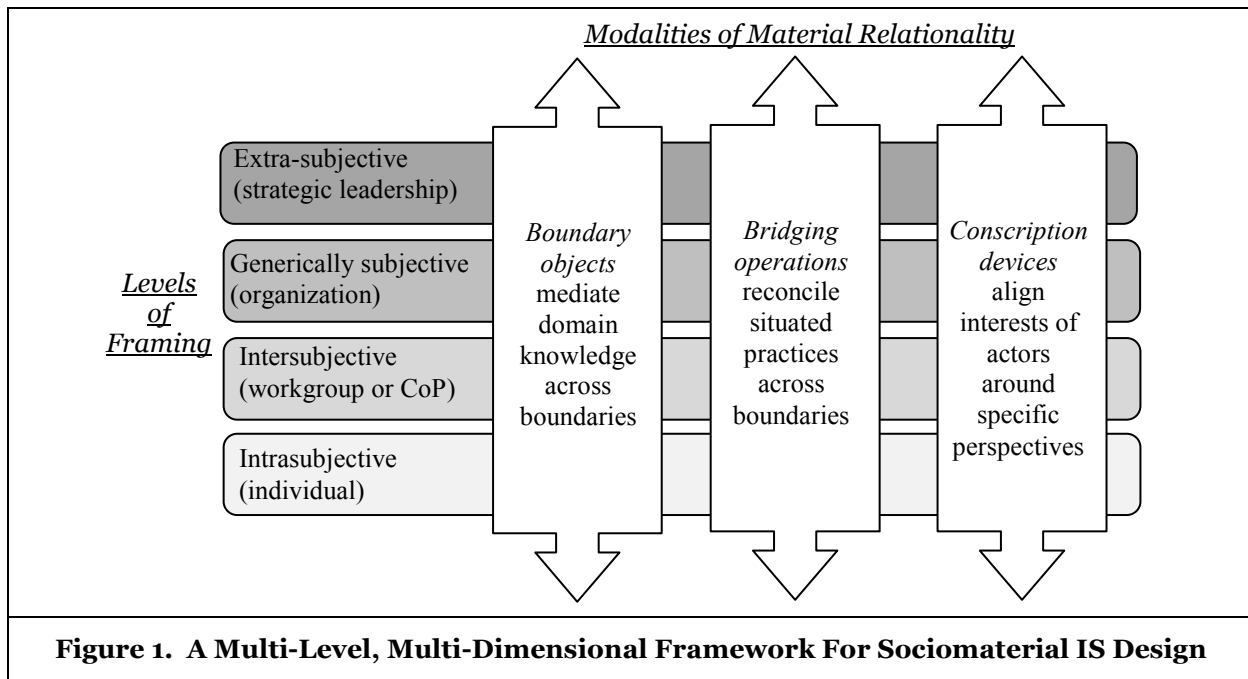


Figure 1. A Multi-Level, Multi-Dimensional Framework For Sociomaterial IS Design

Research Site and Method

IS needs-definition can be viewed as the exploration of an evolving set of sociomaterial ensembles, through which the material and the social are mutually constituted (Orlikowski and Scott 2008). The processes of IS definition are therefore only meaningful when viewed as a historical trajectory or *genealogy* of material overlaps between human and nonhuman ‘actors,’ that is situated within a specific set of evolving sociocultural norms and interpretive structures (Latour 2005). But inscriptions disappear over time, as the IS evolves to fit with an emerging view of organizational goals and processes. To understand enterprise IS redesign, we must capture the IS genealogy, based on a longitudinal, ethnographic study. The genealogical approach allows the modalities and processes by which organizational knowledge and reality are inscribed in an IS to be traced while these are still visible. Each stage of the process of needs-definition can be disassembled, to understand the modalities by which the IS acted as an inscription device, allowing competing or collaborating stakeholder groups to frame the role and purpose of the IS according to their perspectives.

This study explored the design of strategic management systems in a US University (not the author’s own institution) by participant observation in a strategic taskforce for enterprise information systems design over two years. The author attended (as an observer) monthly/bi-weekly taskforce meetings to define changes to the business processes and enterprise systems used for University management. All identities and job titles have been disguised to ensure confidentiality (the institution was not the author’s own). While two members of the taskforce left their employment and were replaced over the period of the study,

representation of specific groups and interests was constant, as summarized in Table 1. Periodic interviews were performed with taskforce participants and other stakeholders, to understand how they -- and their organizational groups -- framed the requirements for change. Graphical and textual representations of business processes, information flows and requirements, organizational problems, and proposed solutions were collected and analyzed, to explore their role in the processes of group design. Discussions from 27 meetings over the two-year period were recorded and interpreted by means of a qualitative discourse analysis (Klein and Truex III 1996; Tannen 1993), supplemented with interactive SSM analysis (Checkland 2000) to identify frames relevant to proposed organizational and IS design changes. The interpretation of frames was validated in ad hoc discussions and in formal interviews with group members as the design proceeded.

Table 1. Taskforce Participants

Regular Attendees:		
Director of Information Services	Executive Director of Student Accounts	University Registrar
Dean of Academic Affairs	Director, Office of Stud. Accounts	Associate Registrar
Dean of Finance & Operations	Director of Financial Aid	Financial Systems Manager
Coordinator of Special Projects	Manager, Admissions & Student Services	Senior Systems Analyst
Director of Marketing (or Manager)		
Ad Hoc Attendees:		
University President	Executive Dean (Academic Programs)	Program Administrators
Academic Deans & Administrators	Program Sponsors (Ext. Org'ns & NGOs)	Academic Committee Chairs

The analysis of data was based on the unfolding of the actor-network. Various levels of framing were analyzed through the use of metaphors (Davidson 1996), (work) system “naming” and implicit perspective surfacing (Checkland 2000), identification of material representations, procedures and forms in the proposed design (Henderson 1999), and content analysis of discussions of backstage arrangements to seek support for change (Law and Callon 1992). Collaboration and negotiation processes in group meetings were analyzed, to understand the mechanisms by which agreement was generated, conflict was managed and resolved, or accommodations reached. The result was a multi-level and multi-dimensional analysis of a complex trajectory of interactions and sociomaterial emergence over time.

Findings

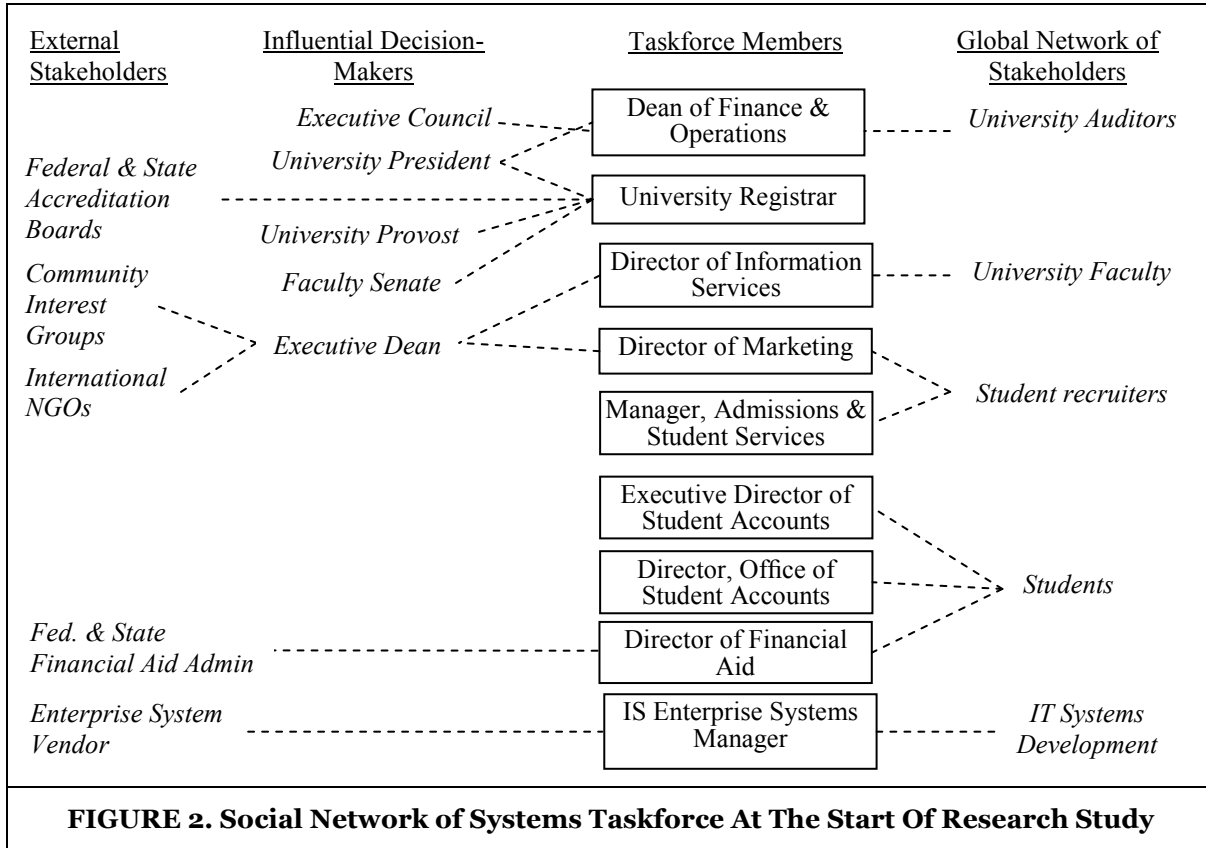
Antecedent Conditions To Design Initiative

The taskforce was assembled by the Director of Information Services and the University Registrar, in response to a perception that the University’s Enterprise Systems (ES) were inadequate for financial management and reporting. The University employed an ES that was used by many similar institutions, but which had not been fully implemented due to political considerations. Several functional groups, in particular Human Resources, were suspicious of the introduction of an overarching administration system, viewing this as an attempt to impose control over their group culture and practices.

The University IT Systems Manager (who did not participate in the taskforce) viewed the ES project as a diversion from the task of administering multiple University IT systems with inadequate resources. Taskforce members were invited from key administrative groups – faculty interests were represented by the Director of Information Services, who was also a member of faculty, and by occasional invitations to faculty Committee chairs, when the subject of discussion warranted this.

The Systems Taskforce represented a wide variety of interests, as shown in Figure 2. The representation here shows Taskforce participants enclosed within a box, with links to global (external to the Taskforce, but internal to the organization) stakeholders and influential decision-makers indicated by dotted lines. There were several key external stakeholders. The President and the Executive Dean saw the University mission as establishing programs in locations where underprivileged populations were underserved and was entrepreneurial in dealing with community groups and international non-government organizations (NGOs) to follow up opportunities for new programs, in the US and internationally. The University

needed to ensure that it was in compliance with accreditation boards and financial aid administration eligibility rules. The interests of various internal stakeholder groups (shown on the right, under the Global Network heading) were represented by Taskforce members and representatives from which were frequently invited to Taskforce meetings. The Taskforce clearly represented the major external and internal interest groups relevant to the University and had strong ties to influential decision-makers.

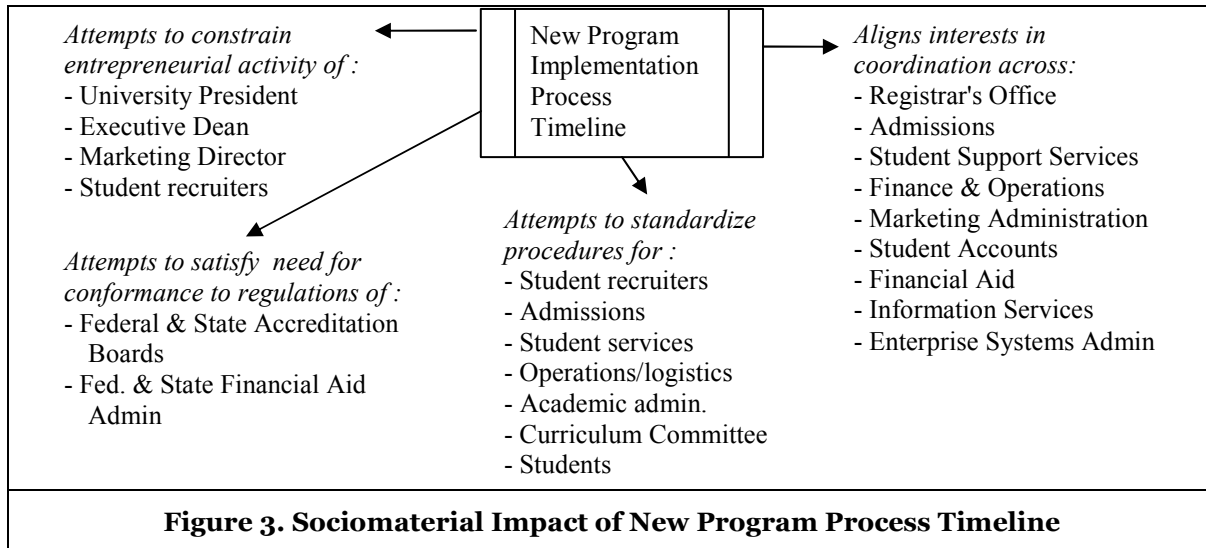


The design process could be viewed as six distinct episodes (Newman and Robey 1992), punctuated by brief periods during which solutions were implemented and the design goals were redefined to fit the new understanding of requirements that followed. Each episode is described here, accompanied by an analysis of the actor-network mobilization and material arrangements that accompanied it.

Episode 1 - Exploring New Program Procedures

The issue facing the Taskforce at the start of the study was how to manage the introduction of new programs. Taskforce members raised the issue that strategic planning was influenced too much by opportunities offered by community interest groups and international non-government organizations (NGOs). From the perspective of the Information Services group, this was a strategic management issue: new programs were announced before the various administrative groups had time to evaluate the implications or prepare for program administration. The University Registrar and the Manager of Admissions complained that students were often recruited to programs for which no classroom location, instructor, or facilities were available. The Dean of Finance saw this as an admissions management issue: students were recruited at the last minute, in order to ensure the program's financial viability, so there was a high degree of uncertainty about class sizes. The Director of Information Services argued that many programs included textbooks and computers in their tuition costs and there was insufficient time for these to be ordered. Financial Aid group members often found that degree eligibility requirements (e.g. the number of instruction-weeks in a specific academic year) were not being met – even though recruiters had promised students that they would be eligible for financial aid.

The Taskforce met frequently to explore the timeline for new programs and to determine the arrangements that needed to be made at various points, including changes to Enterprise System configuration. The *Process Timeline* became a sociomaterial assemblage for the group – both in terms of its negotiation object roles and also in terms of its ability to embody a script that guided practice across the various groups involved. In particular the Timeline aligned the interests of various groups in coordinating material arrangements, as shown in Figure 3.



On the surface, the Timeline – and its embedded formalized procedures – appeared uncontentious. Taskforce members clearly recognized the need for coordination and control across a wide range of related functional groups and were willing to accommodate some changes to practice for the quid-pro-quo of their information needs being met (in particular, obtaining sufficient warning of student numbers and details to do their job). But the multiple perspectives of problems with the current system led to boundary accommodations that were provided on an ad hoc basis.

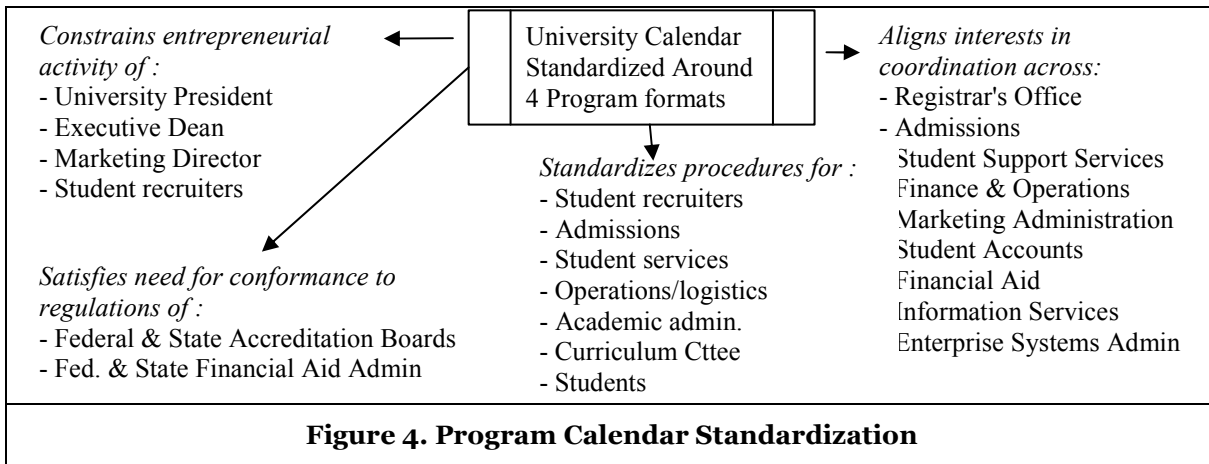
The Information Services Group formalized some interim information management tools – spreadsheets and temporary databases – that were used to coordinate transient information about student and program arrangements that the Enterprise System could not cope with. For example, students were recruited to a program, but could not be officially registered until financial aid applications had been processed and the first year's tuition fee received. Yet books and computers needed to be ordered in anticipation of that registration, as the lead-time was several weeks. A shared spreadsheet of student status allowed the registrar's office to anticipate class size, student services to order books etc., and the financial aid office to assist with student applications. Facilities needed to be booked and instructors engaged, on the basis of class size. So an interim registration database was created and updated with program and student status changes manually until a student's registration was completed, at which point their details were entered in the Enterprise System student database and used for formal program administration.

However, a backstage tension undermined these accommodations. The Executive Dean was unwilling to coordinate program initiatives in advance – by the time that relevant groups heard about new programs, announcements had often been made and the first students recruited. Program start dates were agreed with community groups who wished to sponsor an initiative without consultation with the registrar or the Financial Aid Office. This meant that there was no standard University calendar – programs could start at any point in the year. Each of the organizational groups involved framed key Timeline issues in different ways. Student recruiters worked on a commission basis, so the Admissions Group often undermined formal procedures in order to admit late students, using community group pressure as an excuse. Recruitment for international programs was often administered via NGOs, which added additional uncertainty and an unwillingness to commit to a standard timeline. The Executive Council had agreed that some programs should be cross-subsidized to fulfill the University's mission – this led to a high degree of uncertainty about how a program's costs and economic viability should be accounted for, with

the Finance Group, Marketing, and Administration Groups employing different accounting methods with different cutoff deadlines. Academic planning was often deferred until there was insufficient time for the Curriculum Committee to approve program revisions or new courses. The implementation of an agreed timeline did not resolve these framing differences, as deadlines were open to interpretation.

Episode 2: Understanding Coordination Issues

Recognizing that process standardization would not work, a Taskforce workshop was held to explore the problems faced in new program introduction, with the Executive Dean in attendance. The Information Services Director attempted to generate standardized *procedure flowcharts* that reflected the “big picture” of program administration across all affected groups. This failed to produce a common understanding – it was clear that each group visualized the content of procedures differently. As a result, each group claimed special cases that complicated the flowchart to the point where it was unusable as a shared representation of procedures.



A *cause-and-effect model* (a problem exploration chart) was used to represent the pressures faced by various groups – this became highly fragmented and had to be partitioned several times into subsets of related issues. However, it did prove immensely valuable. Representatives from various functions started to perceive coordination problems from the perspective of other groups. Individuals shared their information needs, explaining why they requested various documents or data at specific times in the process. This led to an improved definition of process information flows. The workshop generated genuine empathy, as representatives of different functional groups explored elements of the problems that they faced and the consequences that these generated. Subsequent group meetings appeared energized by this new empathy. The Taskforce addressed major differences between academic program formats, identifying four different type of program calendar: Semester Programs, Certificate Programs, Quarter Programs, and Ad Hoc Programs. The University Calendar was standardized around these program formats. Start date-ranges for each type of program were defined in the new standard calendar and program introduction requirements were formalized in terms of the lead-time required for the various program-types within each category. The Student Accounts and Financial Aid groups were especially active in this episode, leading discussions about standardization needs and explaining their information requirements in great detail.

When the standardized calendar was introduced, it appeared to have an immediate effect. Operations were simplified, student aid issues were reduced, and the longer planning lead times were felt to have led to higher quality across various academic programs. But the euphoria was short-lived. As the administrative year proceeded, there appeared to be an increasing number of exceptions to these program formats – formalized for historical program continuity or to meet the needs of specific community groups. This led to an increasing feeling of frustration across the global network of coordinated groups and stakeholders and an increasing dissociation by influential decision-makers.

Episode 3: Invisible IS Boundary Expansion

There was a push for expansion of the University's strategic plan, both from the Executive Committee and the President. The Executive Committee wished to take advantage of opportunities offered by private funding agencies and NGOs, while the President wished to explore the University's mission by expanding programs in underserved areas of the US, with aid from local community groups. This led to a tension between the regulating influence of the "standardized" four program formats and the need to operate flexibly to fulfill the University mission.

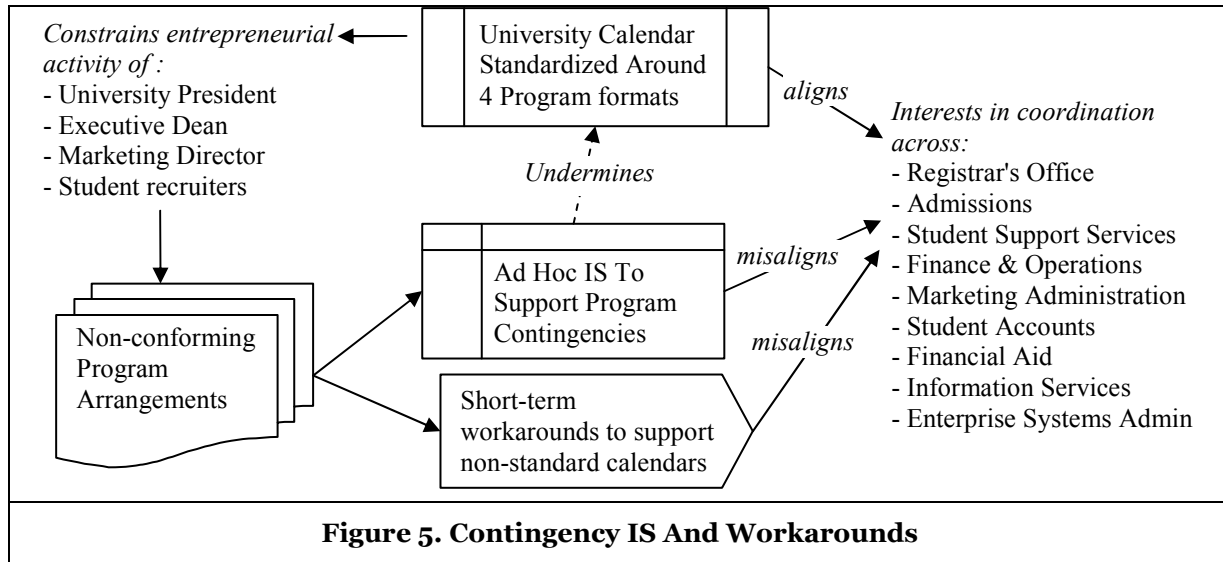
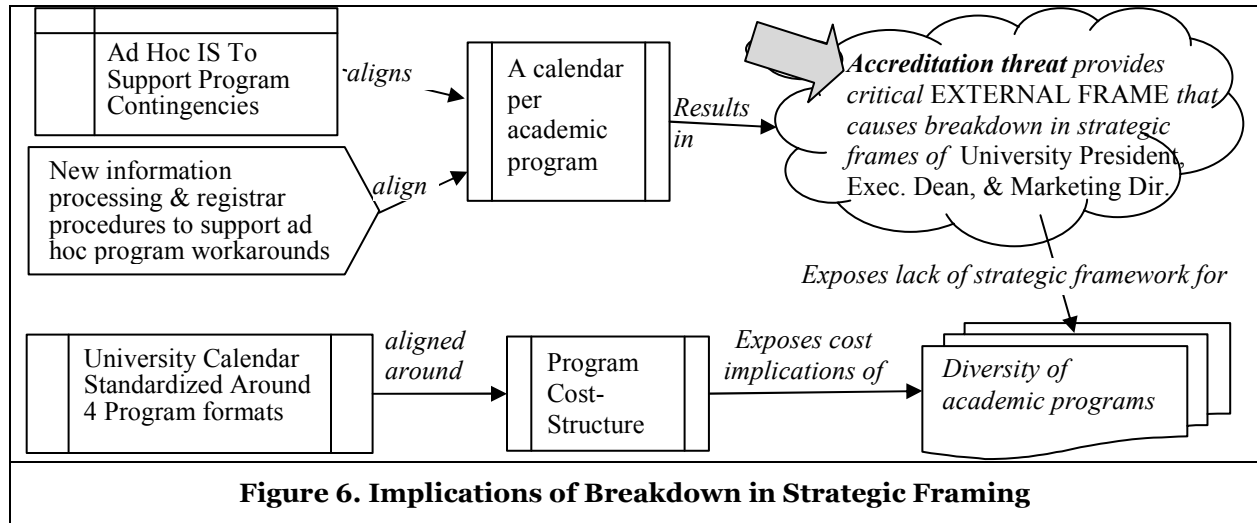


Figure 5 represents the impact of the new IS definition. The constraining influences shown in Figure 4 were rejected: new programs were created that did not accord with these formats and which had shorter lead-times than required for effective planning. The implications of this expanding, implicit information system boundary were slow to be realized. The increasing complexity of operations was obscured by the Information Services group, who developed short-term work-arounds. In effect, this group became a *de facto* coordination system, making phone calls to warn people that action was required, providing interim calculations of student numbers and feeding short-term data to other groups in advance for planning purposes. There was a great deal of confusion, as various groups developed contingency procedures that combined their normal activities with activities which lay outside of their normal practice system boundary. These contingency procedures were viewed as short-term "interfaces" and were largely taken over by Information Services and the Registrar's Office, expanding the scope of both groups. Eventually, matters came to a head when external program accreditation was threatened.

Episode 4: Exploring The Breakdown of Planning

The threat to accreditation refined the minds of everyone, not least the Systems Taskforce. When this group attempted to map out the current planning procedures, they were shocked to discover how much more complex these had grown since the institution of the standardized program calendars. It proved impossible for the Taskforce to model these procedures – there were so many special cases that they felt they were creating "a calendar per academic program."

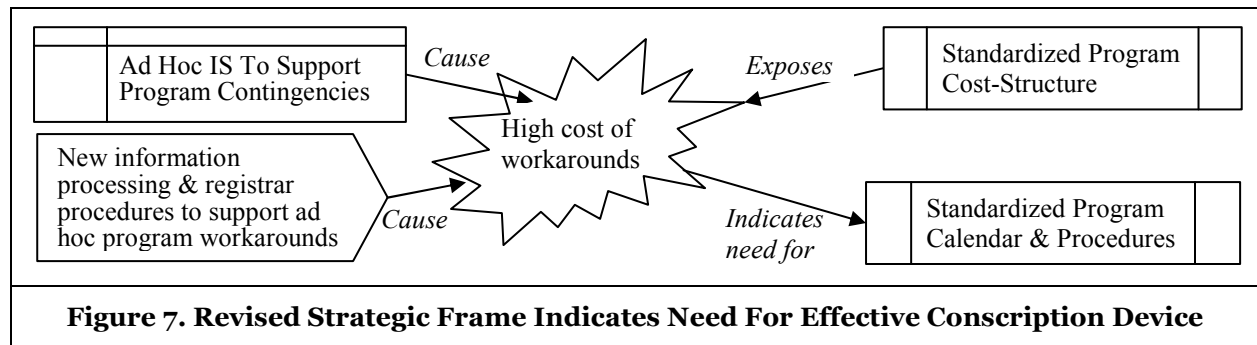
The variety of academic programs was reviewed and the program cost-structure became a new unifying object, as this embodied the concerns of Taskforce members that programs were being expanded without any analysis of the cost implications. An indirect cost analysis was performed and Taskforce members appeared shocked to discover the cost implications of program expansion. The general perception was that the Executive Council was blissfully unaware of the extra work and contingency arrangements that had resulted from this expansion. Various Taskforce members volunteered to discuss issues with individual Deans, with faculty committees, and with individual Executive Board members. The Registrar elected to discuss the seriousness of the situation with the President and the Provost.



Episode 5: Aligning A Standardized Calendar With Senior Management Interests

The Taskforce worked on analyzing the costs of a failure to standardize the University calendar in detail. The “informal cost structure” presented a new coordinating object for the group, who were constantly surprised when a member would report to the Taskforce the results of their investigation into much time and resources spent on workarounds.

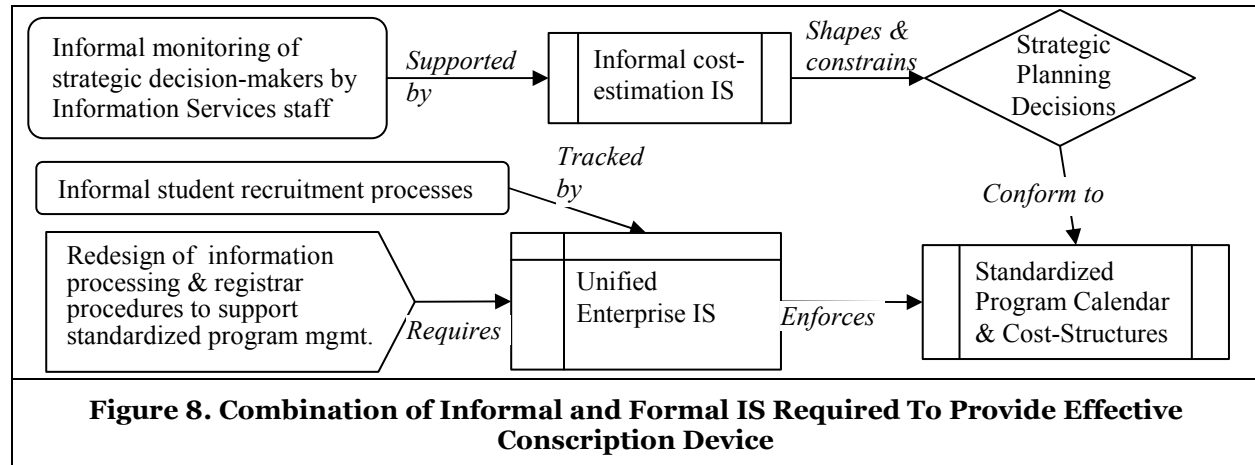
The totals made a huge impression and were presented to key decision-makers individually. This impact was coupled with a realization on the part of various key decision-makers that accreditation was threatened by their new initiatives. The Taskforce received instructions to explore what needed to happen for the University to standardize around a single calendar. Taskforce members now had permission to develop a universal set of procedures. They resurrected ideas that had been abandoned as unrealistic during Episode 2. Eventually, they standardized around a single academic calendar, with two program variations (semester and quarter) and a uniform start-week for all programs. This allowed programs to conform to both accreditation and financial aid requirements without further checking. A set of standardized procedures and templates were created for new programs and courses, without conformance to which these could not be approved.



Episode 6: Implementing Enterprise System Changes

The standardized calendar and procedures allowed changes to be defined to the Enterprise System (ES), so that this could implement the contingency system functions that the Information Services Group had been supporting. ES limitations were no longer a constraint, once various procedures could be defined with few special cases (for legacy program completion). It appeared that the main stumbling block had simply been an unwillingness to invest IT development time and resources without some expectation of stability. The Enterprise System now managed to track the informal practices required for the system to work – for example, it was now possible to track student status before their registration was completed

and at times when they were registered for a program but not for courses. This allowed planning to take place for facilities and logistics much earlier, ensuring a higher quality of delivery with fewer problems. Various accreditation boards were now satisfied that the programs were stable and well-managed. Student satisfaction also increased, as financial aid application was simplified and became more certain. Not least, the cost structure of programs was reduced drastically, providing major benefits to the University and allowing it to fulfill its mission more effectively.



Of course, the introduction of the new systems was not without problems. Recruiters felt that they were being cheated of the opportunity to recruit late students and some compromise had to be made to keep this group on board. Key decision-makers had to be monitored carefully and reminded of the implications of abandoning the standardized calendar and procedures regularly. The Information Services Group developed an informal cost estimation system (a spreadsheet) that reflected the true costs of introducing a new academic program, based on the cost estimates generated during Episode 5. Each time a new program was planned, this was used by Information Services staff to reflect the true costs of introduction – which reduced the number of new programs considerably and “trained” strategic managers to think strategically, in terms of cost and accreditation issues.

Synthesis: A Trajectory Of Sociomaterial IS Design

The analysis of field study data presented above exposed a set of interrelated ways in which various forms of negotiation object supported different aspects and levels of meaning in enterprise IS design. This synthesis explores how these mechanisms and modalities combine to provide a coherent sociomaterial assemblage. At various levels of interaction, different forms of material negotiation object or mechanism mediated the framing of change, as summarized in Figure 9.

The actions of these modalities at each level have been summarized in Table 2 below, which highlights some previously unrealized properties of each mode of mediation. For example, a boundary object is usually conceptualized in terms of its inter-group mediation. When examined at the intrasubjective (individual) level of framing, boundary objects challenge and extend the frames which derive from the individual’s experience as a member of a specific community of practice (e.g. a specific functional organizational workgroup). The boundary object appears to introduce a discontinuity at the boundary between the individual’s worldview and an external representation, which causes them to explore the boundary in order to evolve their understanding – otherwise known as “breaking frame” which is the basis of learning (Goffman 1974).

Bridging operations typically refer to the mechanism by which local knowledge is transformed into generically subjective knowledge by developing “standard” or “best” practice (Weick 1995). A similar level was seen to operate at the individual level, allowing individuals to reconcile and translate conflicting frameworks for action by means of a scenario (which could be articulated) that provided a new script for how to act in novel circumstances. When embedded in a material device such as the design of a technological information system, this script was observed to constrain and direct individual action, providing a conscription device.

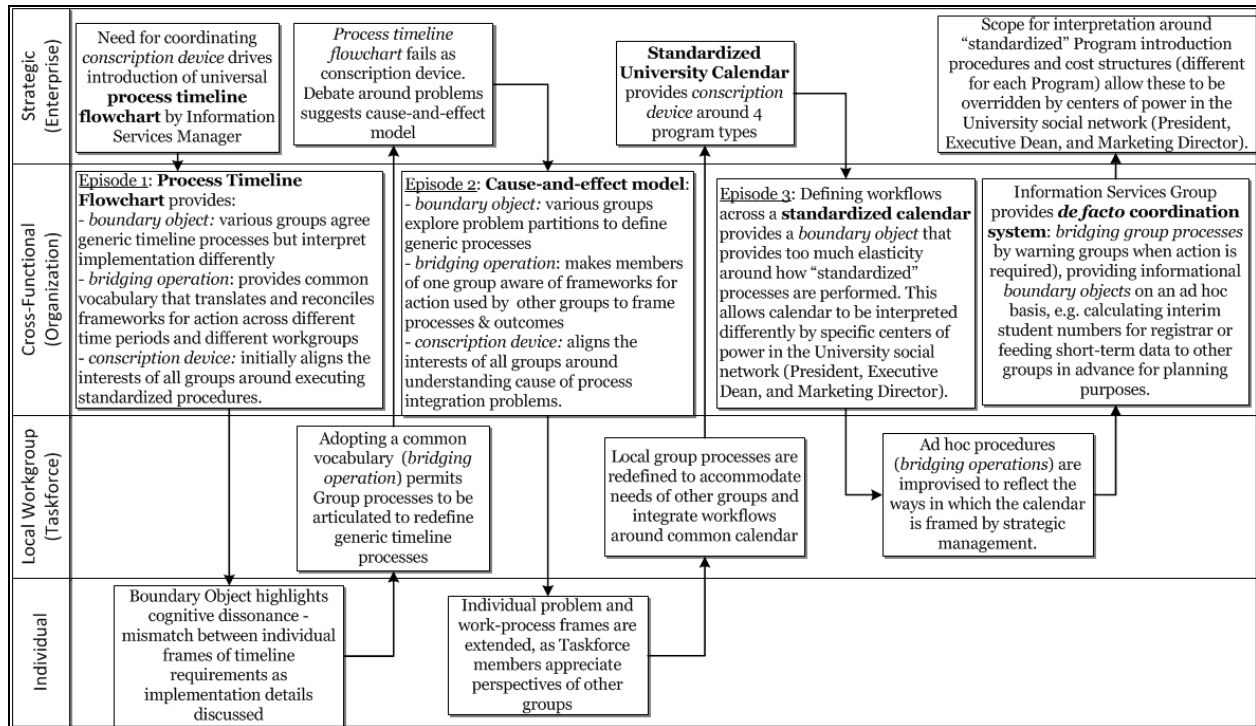


Figure 9(a). Modalities of Sociomaterial Trajectory of IS Design Across Episodes 1-3

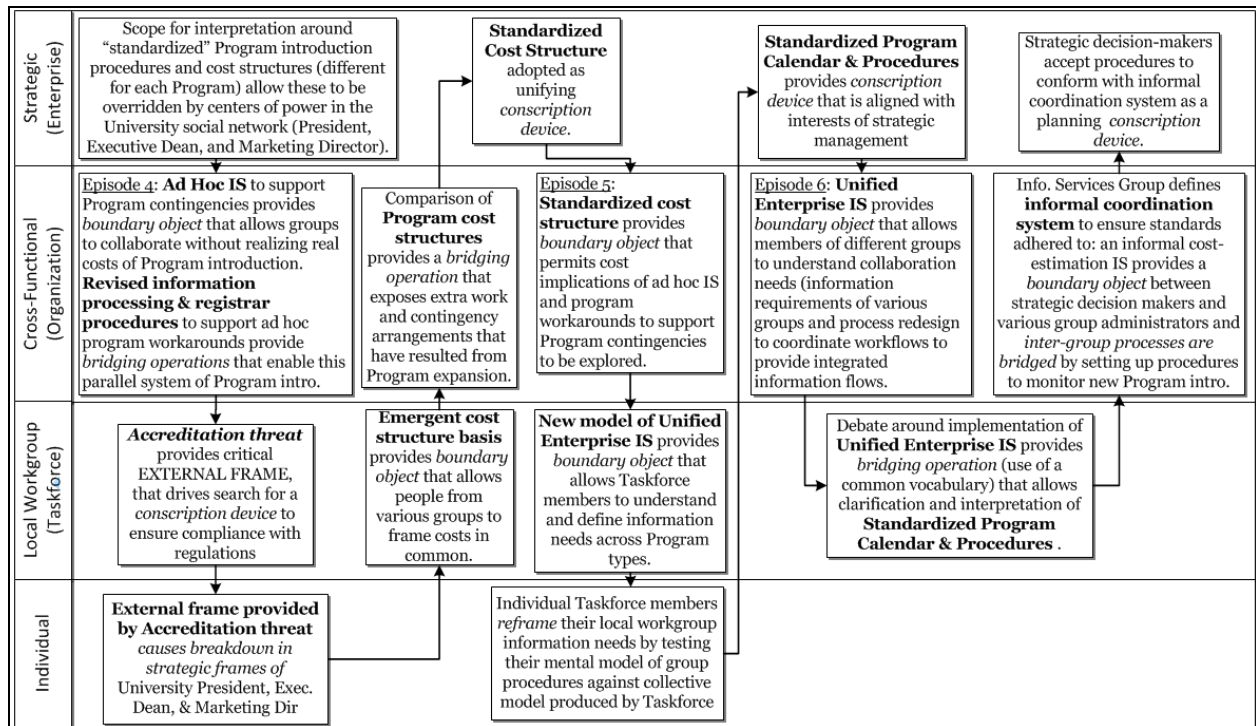


Figure 9(b). Modalities of Sociomaterial Trajectory of IS Design Across Episodes 4-6

At the intersubjective level, material objects such as models and process-definitions provided a common vocabulary that bridged domain-specific worldviews. External representations of the IS or work-process design provided boundary objects that permitted translations of domain-specific frameworks for action.

These allowed the design Taskforce group to make sense of how the organization should operate and were formalized through a negotiated script for action that defined how material devices such as IS operated.

At the generically-subjective level, change requirements were negotiated across the political and practice-based frames of various functional groups (communities of practice). Boundary objects mediated the exploration of change requirements, while bridging mechanisms provided a unified framework for action that allowed representatives of various groups to make sense of change in a way that was nominally collective. Shared models were most often implemented by a technology-oriented design group that represented a subset of the organizational groups involved in process redesign. As a result, the scripts embedded in technical IS may represented only a subset of the originally-intended framework for action. This was demonstrated by the implementation of “standardized” Program introduction procedures which could be – and were – circumvented because of the room for interpretation. Because of the framing translation introduced by technology and procedure design interpretation as an IS is implemented, it may not be effective at providing a conscription device that supports the original intent.

Finally, at the strategic management level, the impact of political centers of power on the social framing process – and the ability for powerful managers to subvert a design implementation – were demonstrated by this field study. Redefinition of organizational structures, roles and responsibilities, while ostensibly coming under the purview of process redesign, ultimately resided with strategic managers. Their interests influenced the implementation of new frameworks for organizational action, with a tendency to maintain the status quo. Only a powerful, external threat such as that posed by the accreditation issues in this study, could disrupt the social influence of these centers of power around which design translations are aligned. In the absence of such a threat, the study demonstrates how ad hoc arrangements and material devices could undermine and subvert the conscription power of formal work procedures and IS.

Table 2. Multiple Levels of Interaction In Design

Framing Level	Boundary Objects	Bridging Operations	Conscription Devices
<i>Individual (Intra-subjective level)</i>	Individuals explore the boundary between their internal, cognitive worldview and external representations of reality, to make sense of how the organization operates.	Individuals reconcile external perspectives with their internal framework for action by imagining practice scenarios. This evolves their internal script for how to act in specific circumstances.	Individuals interact with preexisting tech. designs, organizational procedures, information systems, rules, and standards – that direct how they work & constrain understanding of what is possible.
<i>Intra-group (Inter-subjective level)</i>	Groups of actors explore and negotiate a collective understanding of individual worldviews using external representations to translate and reconcile collective frameworks for action across knowledge domains.	Groups of actors negotiate the meaning of work and technology around emerging representations of work to provide a common vocabulary that allows them to negotiate a collective understanding of change requirements.	Actors align their negotiated interests around specific definitions of group processes and resources to provide a script that defines how material devices will translate, transform and unify work practices across knowledge domains.
<i>Inter-group boundaries (Generically subjective level)</i>	Representatives from various org. groups explore multiple requirements for change across the social network of affected stakeholders to produce design requirements.	Representatives from various CoPs explore and negotiate scenarios that make sense of how the unified framework for action will integrate knowledge domains and communities of practice.	A design group (a subset of reps from technically-oriented CoPs) produce a design specification that defines how business processes and technology systems will implement the script adopted by the Taskforce.
<i>Strategic management (Extra-subjective level)</i>	Organizational structures, roles and responsibilities are negotiated around various representations that reflect centers of power in social networks.	Organizational structures, roles and responsibilities are reconciled using standardized objects (org. charts and job definitions) that reflect the status quo.	Informal, material arrangements and practices to align the interests of strategic managers with design implementation may constitute a parallel, informal IS that subverts the formal IS.

Discussion

The research questions that motivated this study asked: How does enterprise level IS design and business alignment unfold? How do organizational managers and representatives of diverse business groups transcend an existing set of fragmented, local knowledge and work-practices to produce an enterprise-level business process model? The findings demonstrate how sociomaterial assemblages of organizational practices, structures, and worldviews (interpretative structures) emerge from the material overlaps between human and nonhuman action (Law 1991). The study explored the evolution of enterprise IS redesign assemblages, tracing how both practice and technology are temporally emergent in practice (Pickering 1993). By employing an actor-network approach to the analysis of direct, indirect, or technology-embedded agency, this study was able to expose the scripts, intentions, boundaries, and constraints-on-use of those who designed and configured them, ordering the messy processes of interaction and negotiation into a genealogy of design emergence (Akrich 1992; Latour 2005; Law 2004).

The study analyzed three modalities by which non-human objects which result from design negotiations - such as design models for an organizational IS, or technical/procedural design implementations - enact a form of embodied agency or performativity:

- *Boundary objects* mediate translations across knowledge domain-boundaries in an informational ecology of practice (Star and Griesemer 1989);
- *Bridging operations*, to reconcile situated practices across organizational boundaries (Weick 1995);
- *Conscription devices* align the interests of organizational actors around a specific representation of organizational or technological change, achieving political domination (Henderson 1999).

By analyzing the role of these “negotiation objects” at multiple levels of framing, the study revealed previously unrecognized modalities for their material relationality. In particular, boundary objects are usually conceptualized at the group level, in terms of concepts, procedures, maps or models that are sufficiently well-defined to support collaboration across group boundaries, but sufficiently elastic to permit detailed practices to be interpreted differently by various groups (Star and Griesemer 1989). Studies exploring the operation of boundary objects tend to conflate individual and group framing effects in analyzing collaboration at the boundary between groups. This means that boundary objects are usually seen as producing a *unified* framework for practice at the boundary (Carlile 2002). The findings of this study suggest that view to be overly simplistic.

Employing a multi-level analysis of design sensemaking was critical to expose interaction effects (Drazin et al. 1999). By analyzing sensemaking at each of four levels during each episode, the findings exposed a trajectory of interactions between individual (intra-subjective) and collective group (intersubjective) frames, between collective and negotiated (generically subjective) frames, and between negotiated and strategic/political (extra-subjective) frames. These interactions affected how both organizational problems and IS solutions were defined. Exploring the interactions between levels of sensemaking exposed the reasons why IS design fails to satisfy organizational expectations and leads to unintended consequences (Orlikowski and Iacono 2001). Material devices and representations that acted as *boundary objects* at the group level introduced framing discontinuities (breakdowns) at the individual level that allowed individual group-members to translate or integrate frames - it was clear that individual frames were not shared by all group members. Reconciliation or translation of frames at the group level occurred because individuals revised their internal frames and negotiated new perspectives. These were made sense of across groups by means of bridging operations (Weick 1995). The enactment of *bridging operations* such as the routinization of a shared vocabulary for a specific area of operations or a the joint production of design representations provided a mediating mechanism that allowed individual frames to be reconciled with the frames presented by others. This enabled the group to make sense of - and therefore agree generic organizational “knowledge” that concerned the IS design. Negotiations around material *conscription devices*, although predominantly operating at the group level, were manipulated by individuals, especially those who occupied centers of power in the social network of design participants.

This study explored alignments between the networks of actors, situated practice, material objects, and politically-oriented goal definitions that drive the design of enterprise information systems in practice. It exposed how misalignments between social and material enactments arose because of breakdowns in political attachment or local group mobilization. But breakdowns also exposed the social and material relations enacted by the IS, evolving definitions of more sophisticated work-goals and practices and

developing the organizational role of both human and material boundary-spanners-in-practice (Levina and Vaast 2005). This level of influence has been termed *extra-subjective* here, as strategic managers were able to direct and constrain key design attributes without ever appearing at Taskforce meetings. Enterprise IS redesign must constantly align stakeholder-negotiated interests with those of key decision-makers who are powerful enough to sponsor, disrupt or bypass the sociomaterial arrangements required for a stable IS design. Strategic managers and other key organizational decision-makers do not often engage directly in redesign initiatives. Instead, they are shadow figures in the background, whose preferences and tolerance for change are negotiated in backstage negotiation spaces (Law and Callon 1992). The meaning of organizational work is managed by managers who enact strategy by generating points of reference – for example sponsoring certain initiatives or disapproving of particular responses (Smircich and Morgan 1982). Their influence may be inferred from the ways in which less powerful participants constrain their own choices or align themselves with politically acceptable compromises.

Conclusions

This study uses and extends upon a sociomaterial view of organizational IS (Orlikowski and Scott 2008) by relating this to multiple modalities of IS translation across organizational boundaries and to multiple levels of framing in managing the meaning of IS performativity in design. In comparison with studies that emphasize the social context of enterprise IS design at the expense of material constructs, this research study develops and applies a conceptual framework that provides an epistemological lens by which we may understand interactions between the social and the material context of design. Previous studies of sociomaterial practice in IS-related change have focused largely on group levels of analysis (Leonardi 2011; Orlikowski 2007; Wagner et al. 2010). The findings presented here demonstrate how multiple levels of sensemaking, translation and the alignment of political interests come together to provide the basis of a newly-conceptualized information system. This perspective adds a new dimension to the conceptualization of sociomateriality, the influence of power-structures in the management of meaning and the influence of backstage negotiation spaces in managing the meaning of enterprise IS.

The findings have consequences for both research, in the study of such initiatives, and for practice, in the way that we manage these. We have proposed three modalities of negotiation object, that mediate meaning in IS design: the use of material assemblies to provide boundary objects, support bridging operations, and enable conscription devices. By exploring the operation of these modalities at multiple levels of sensemaking, or framing, we are provided with a framework for analysis that may explain many of the unintended consequences of IS design noted by previous research studies (Orlikowski and Iacono 2001). A major implication for research is to suggest that sociomaterial performativity results from the *management of meaning* across a diverse group of design participants. As individuals, workgroups, and members of multiple communities of practice collaborate to conceptualize and negotiate IS support for boundary-spanning business processes, they enact new organizational meanings that may not be understood fully by any single person. These meanings are supplemented or undermined by backstage negotiations and political influences. The implication of this finding for IS design practitioners is that we need to manage and monitor interests of strategic managers and powerful decision-makers continually throughout a design initiative. Boundary accommodations for political interests may undermine the whole purpose of the design, as demonstrated here – the implications of such accommodations need to be negotiated thoughtfully with strategic managers and their implications communicated clearly.

Organizational information cannot simply be conceptualized as a shared repository (a boundary object). Their role and purpose are defined by negotiating systems of meaning that make sense of social networks, functional groups and communities of practice, associated business processes, knowledge and information resources, and IT system resources (Balogun and Jenkins 2003; Smircich and Morgan 1982). It is only by negotiating around these elements as a coherent whole that enterprise IS definitions emerge. This is what is meant when we speak of the processes of constitutive entanglement (Orlikowski and Scott 2008). Reality is messy. Multiple worldviews often collide in the interpretation of an object, so its identity becomes ambiguous and situated in the local context of use. Throughout this process, the identity of objects may diverge, with various communities of practice emphasizing *different* roles and meanings for the same object (Law 2004). We can only understand how sociomaterial assemblages come into being by exploring the processes and modalities by which competing conceptual frames of the IS role and purpose are reconciled.

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