A Framework For The Co-Design of Business and IT Systems [1]

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Abstract

This study deals with the intersection of knowledge and action: how knowledge is developed, transformed, interpreted and used to change systems of business process and IT so that stakeholders may make effective decisions and take effective action in their work. The co-design of business and IT systems is a process within which business systems of human activity and IT systems of information processing are mutually constituted. It requires the negotiation of competing technological frames across multiple knowledge domains. Three major challenges hinder effective innovation: (i) a mismatch between goal-driven IS design methods and the need for cross-functional knowledge-sharing, (ii) the distributed and partial knowledge possessed by stakeholders from diverse groups; (iii) the need to maintain interpretive flexibility across cycles of discovery and analysis. This paper develops an analytical framework for integrating knowledge frames across stakeholder groups, to provide a common language for the co-design of business and IT systems.

1. Introduction

The traditional waterfall approach appears to dominate the design of IT systems in organizations, even when this approach is patently inappropriate to the type of IS or the degree of organizational uncertainty [1]. This may be because we have no compelling alternative model with which to replace it. We have spiral process models, that reflect an evolutionary approach to solution-definition. But the detailed activities required for emergent design are ill-understood. The most common spiral models are overly goal-directed, focusing on problem closure through a "try it and see" engineering approach, rather than legitimizing the problem inquiry and synthesis required for situated design [10]. A new generation of interaction design and agile design methods has recently emerged, based on a recognition that interactive mechanisms are required for user involvement, for design requirements to emerge. But these methods lack theoretical underpinnings and also adopt the goal-directed, consensus assumptions of traditional methods. We lack a methodological framework that focuses on the processes involved in the design of an organizationally-situated information system: the co-design of business (process) and IT systems. Business process (re)design analyzes how to improve the organization of work, focusing on changes to organizational management structures, work practices and work-flows, human-human communication, and reward structures. In contrast, IT systems (re)design analyzes how to improve the effectiveness of data processing and the efficiency of systems of technology. Unless carefully managed, the two analyses may become incommensurate, with priorities arising from the business design subsumed to technology needs. This is largely because the reductionist methods employed for IT systems analysis fail to represent the complexity of the organization's business processes and attempt to amalgamate rather than recognize the multiple goals of various stakeholder groups and business process actors [7, 16]. The study discussed in this paper examines this need, not from the perspective of defining a prescriptive process model, but to produce a framework and meta-models of the socially-situated processes of *knowledge integration* in the co-design of business and IT systems, so that we may better understand and manage this process.

2. Design for Business and IT Systems

2.1 Design framing as social construction

The social and technological contexts of action are mutually constituted through the application of relevant "technological frames" [2, 3]. Various social groups ascribe sets of meanings to their understanding of the role and purpose of technology in a particular

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context. Some of these frames are shared across stakeholder groups and some are radically different, leading to consensus over some aspects of related change and conflict over others. Organizational actors interpret and redefine a technology artifact as they adapt it to their purposes, based on their prior experience of similar technologies or applications [3]. The eventual form of a technology is determined through a process of closure, "by which facts or artifacts in a provisional state characterized by controversy are molded into a stable state characterized by consensus" [17, page 109]. The social construction of technology literature asks under what circumstances is the "black box" of technology closure taken up and reexamined by different groups. Studies tell us that this occurs when *interpretive flexibility* is maintained [3, 14]. Interpretive flexibility means that technological artifacts and systems have different meanings for various organizational groups and their role is interpreted differently according to who is using the system for what [3]. Their role, purpose, and forms are subject to negotiation by organizational stakeholders and may change over time, as users adapt IT systems to their needs [14]. Maintaining the equivocality of design "knowledge" across multiple cycles of analysis is critical to avoiding premature closure of a design problem. So an effective method for design must open the black box of technology to inspection by non-technical stakeholders, by permitting them to examine and redefine the role and purposes of IT systems adaptively and in ways that include the knowledge perspectives of multiple groups.

2.2 Five problems of IS design

Methods for organizational information system design typically suffer from five problems [10]:

1. *The design problem.* IT design methods artificially separate the conceptual and social processes of IS design – the giving of form to a set of process changes supported by technology and the implementation of that form by means of IT system implementation. Design activity cannot be crammed into the single stage of system development referred to as "design". Organizational problem analysis, requirements specification, design, technical system implementation, and organizational change are inextricably intertwined [9].
2. *The process problem.* IT design methods employ a "rational" model of problem-solving. IT system design is based on an ordered, decompositional analysis of problems, that assumes that all requirements for a solution are known. This is a poor fit with the "opportunistic" approach employed by IT analysts, where the problem is frequently reframed to fit available technology solutions rather than analyzed [12, 15].
3. *The framing problem.* IT design methods presuppose a design problem that is unitary in nature and exists independently of the analyst, whereas organizational actors are faced with wicked problems that are interrelated, subjective, and socially constructed among multiple stakeholder groups [19].
4. *The teamwork problem.* IT design methods are based on an individual model of understanding, so are ill-suited to the facilitative processes of communication, joint knowledge construction, and coordination across diverse organizational groups that are faced by IT systems analysts in practice [7, 16].
5. *The context problem.* IT design methods assume that there is an optimal design, based on objective criteria, ignoring the situated, socio-cultural context of IT systems use [13]. Design gives a *form* to a technology artifact, that requires the IT analyst to consider both technical and social factors [4]. For example, analysts may choose whether users should be prevented from changing certain data, or defining the sequence of user interactions, privileging system integrity over support for an effective flow of work-processes.

To resolve these problems, we need to employ a design approach that cycles iteratively between opening up the (organizational/process) problem and narrowing down potential IT solutions. The "five problems" of IS design are not mutually exclusive, but are themselves interrelated. We therefore need a systemic method of analysis to resolve these [10]. We lack ways of *representing* both halves of this dialectic with sufficient complexity. IT design representations tend to present a static view of organizational structures and relationships, that is out of date as soon as it is produced. As designers interact with users and other stakeholders, new information emerges that makes existing goals a poor fit with emerging requirements [15]. Goals are not only redefined, but they are gradually and *partially* reframed – often implicitly and subjectively. Far than being planned or guided, definitions of a design problem *and* solution converge in tandem [9]. "The issue becomes identifying what guides the discrimination between significant and insignificant" [22, page 105]. Change requirements arising from the analysis of organizational problems, business processes and knowledge exchange tend to be subsumed to the integration and efficiency needs of IT systems [7]. Non-technical stakeholders need to be more than token participants in this process.

2.3 Framing IS design solutions

Business processes and IT systems are mutually constituted through the process of negotiating technological frames around organizational knowledge [21]. Collaborating organizational groups typically face problems for which the solution involves a combination of process change and access to new (or synthesized) organizational knowledge. They debate what knowledge they wish to exchange and manage at the boundary between groups, based on what their current IT system does not provide. When they obtain access to this information, they take advantage of opportunities in their business environment by innovating new business practices, that require further cooperation between groups, needing yet more exchange of organizational knowledge, and so on [11]. The IT professional does not view this process as emergent, because they lack ways of sharing knowledge about the rationale for evolving IT systems requirements. So IT professionals view users as never knowing what they want. A design approach that supports emergent knowledge processes must employ design representations that surface and make explicit the differences between how various organizational groups understand organizational processes and goals, then present a way of reconciling or negotiating priorities, based on different stakeholder-group framing perspectives. To explore how we may do this, we employ an approach based on the surfacing and representation of technological frames [2, 18].

The concept of a technological frame is used to denotes a shared construct that all members of an interest group call upon to guide their joint actions. It does not represent an individual understanding, rather it focuses on the intersection between what individuals understand [2]. A technological frame thus appears to correspond to a form of implicit consensus, that represents how members of an organizational group view the role and purpose of technology in their world [18]. It was argued above that design is most effective when technology systems and artifacts possess interpretive flexibility. Perceptions of whether an information system or artifacts "works" or does not “work” depends upon who uses them and how they are used. Organizational groups will modify or refine the artifact's form to solve the problems that they experience within their context of action. "Each problem and each solution, as soon as they are perceived by a relevant social group, changes the artifact's meaning, whether the solution is implemented or not" [3, page 52]. The process of organizational IS design requires a dialectic between defining *global technological frames* -- what needs to be in place for the system of human-activity and knowledge-processing to “work” (business process change) -- and defining *local technological frames* -- how local practices and emergent knowledge processes should be supported with technology (IT systems design).

2.4 Translating technological frames across organizational boundaries

Effective design requires the negotiation and translation of local knowledge across functional or organizational domain boundaries [5]. This may be achieved through the mediating action of *boundary objects*: knowledge-representations or artifacts that convey sufficient information about the intersection between two knowledge domains for people to coordinate work at the boundary, but which are sufficiently elastic to support multiple interpretations of the locus of intersection between domains [21]. For example, your doctor may write a prescription that is filled by a pharmacist. Neither of the two needs to understand the work of the other to coordinate their part of the work of providing you with treatment. The pharmacist does not need to understand what is wrong with you, to dispense the medicine, nor does the doctor need to worry that you receive the correct medicine and understand how to take it. But you (as the patient at the intersection of their two jobs) need the physician to write a prescription that the pharmacist can understand and need the pharmacist to dispense the drug in a manner consistent with the physician’s instructions and to provide you with a written label instructing you how the drug should be taken. The intersection of three domains: the work of the physician, the work of the pharmacist, and your actions as a patient are coordinated by means of the prescription boundary object.

A boundary-spanning framework for design must adapt knowledge across multiple domains of application by reconciling various local frameworks for action into a coherent global framework of business activity and goals. This type of tacit knowledge-resource is not amenable to codification or externalization in a written form. Boundary objects contain the potential for the transfer, translation or transformation of knowledge, as members of various organizational groups collaborate in shared work. Different types of boundary object support different types of organizational knowledge-sharing [5, 21]. *Maps* and *models* representing the intersections of organizational domains provide the greatest potential for knowledge transformation, as they permit stakeholders to project their own interpretations of content onto the boundary object but to coordinate their work around a common set of related objects. This permits innovation and adaptation. Other forms of

boundary object enable tighter coordination between organizational groups and domains, but also ensure closer conformity between groups in the ways that they interpret joint knowledge. The definition of *shared forms and procedures* permits one group to impose control over ways in which another group performs certain tasks, while the coordination of work around *shared repositories* permits groups to share informational resources without adopting another group's categorization schemes [21]. Each of these boundary object forms can be used to represent the stakeholder knowledge required for IT professionals to understand and validate different types of business-process or IT system related knowledge, as discussed below.

3. Elements of a method for the co-design of business and IT systems

The discussion above argued that IS design needs to be treated as a dialectic process, cycling between "opening up" business processes and their associated knowledge problems, and "narrowing down" changes to systems of human work-activity and their supporting systems of IT [10]. To manage change successfully, we need a framework for action that mediates across organizational group boundaries, to provide a common language for design participants. This may be achieved through focusing on the use of boundary objects that translate knowledge between stakeholder domains [5]. In this way, we may manage the dialectic between opening up the interrelated, wicked problems perceived in the context of boundary-spanning, emergent knowledge processes, and narrowing down the changes required to local systems of IT-supported work. Figure 1 illustrates the elements of a process to manage the dialectic between the formation of global technological frames, that relate wicked problems to a need for change to business processes, and local technological frames, that relate group practices and purposes to the support provided by wider, organizational IT systems.

Although approaches to each of the four types of representation have been suggested by the discussion above, the problem remains of how to integrate these representations to provide a "common language" for design across all stakeholder and analyst groups. One possible solution is provided by the suggestion that collective design framing may be driven by the early definition of a particular type of boundary object.

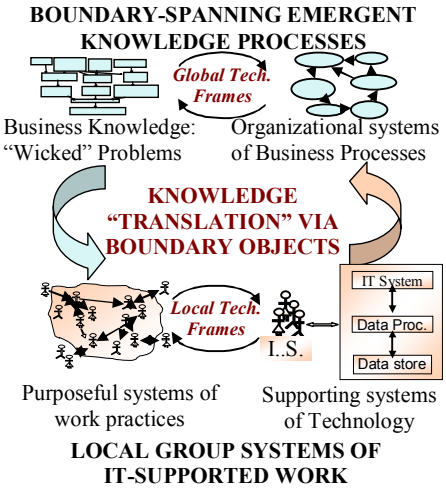

Figure 1. Systems of change in the co-design of business and IT systems

Darke [8], in a study of architectural design groups, observed that they mobilized their understanding around a "primary generator" concept. This concept provides an integrative example of the *form* that the design will take, enabling the group to visualize the designed product. For example, an architect described how his team was inspired to produce a design: "Once we'd flipped from a stack dwelling to a house on the ground, we assumed a terrace would be the best way of doing it" (Darke, 1979, page 185). However, whilst Darke's concept is static, her design participants are members of the same professional group, participating in a coherent knowledge domain. To support boundary-spanning design, I call upon the findings of a prior study, where it was observed that the development of shared meaning in boundary-spanning design was driven by the production of a *series* of primary generator concepts, each of which complicated the vision provided by previous ones. I have termed these "mobilizing visions", based on their ability to cause a catalytic breakdown [23] in collective understanding. This breakdown results in a discontinuity of knowledge about organizational change goals that complicates the debate about process and IT system changes, as prior assumptions are questioned [11].

The methodological framework shown in Table 1 was developed from the process model of Figure 1 to identify suitable forms of boundary object for the co-design of business and IT systems. The framework supports the emergence and negotiation of interpretative flexibility in boundary-spanning design by means of boundary objects that create a "common language" of representations, to mediate between knowledge and process change requirements, global

and local interpretations of organizational goals, and to integrate work-practice support needs with IT system goals. The intent is to represent multiple perspectives on the context of analysis, a comparison between which produces breakdowns in contextual knowledge and so develops the extent of shared understanding across stakeholder groups. The following section presents an example of how the framework is applied, reflecting on its use by groups of experienced IT analysts.

Table 1. Analysis framework

BOUNDARY-SPANNING, EMERGENT KNOWLEDGE PROCESSES	
Business knowledge: wicked problems	***Systems of business processes***
Model interrelatedness of problems & intervention boundary, to clarify context-related frames.	*Map* process flows and organizational change boundary, to clarify process-related frames.
KNOWLEDGE TRANSLATION VIA BOUNDARY OBJECTS: *MOBILIZING VISION*	
Produce boundary-objects to integrate global technological frames with local technological frames, to induce breakdowns in collective organizational vision..	
LOCAL GROUP SYSTEMS OF IT-SUPPORTED WORK	
Purposeful systems of work practices	***Supporting systems of information technology***
Map systems of human activity to frames related to group work-goals,	Translate group goals for change into *standardized forms and procedures*.

4. Applying the framework

The case example was developed from a graduate student project: to investigate the diverse requirements for business and IT systems change in a car dealership employing approx. 45 people. The students were all experienced IT analysts, so this example provides an excellent example of how real-world experiential knowledge can be constrained by too narrow a vision of the interrelatedness of the framework elements and too little attention to interpretive flexibility.

4.1 Business knowledge as wicked problems

The first element in the analysis framework is the representation of global technological frames around which stakeholders can negotiate change. An analysis of wicked problems is related to an analysis of business process performance and changes are defined to how work is coordinated across functional work-groups. The core task in starting a design investigation is most frequently that of identifying a problem in sufficient depth that a set of goals for change may be defined. The technique presented here has been developed over several years, as a way of modeling wicked problems by separating out causational problem elements and including the perspectives of multiple stakeholders *for the same problem*. There appear to be three key issues:

- "Root-cause" problems are conflated with "symptom" problems, as people most often experience the symptoms and do not understand their system of work processes in sufficient breadth to determine the cause of these problems.
- Problems are not related, but represented as separate streams of causality. To be useful, a problem analysis must analyze when a problem arising from performance of one task causes problems for other tasks. In particular, problems related to one area of operations are often mis-categorized as problems relating to a different area, when these share a common consequence.
- Most people only experience part of a complex problem: to be useful, a problem analysis must reflect a view of the situation that integrates problem effects across multiple groups.

Figure 2 provides an example of this phenomenon. *Due to space constraints, this is a partial model.* When the owner of the car dealership was asked what his core problem was, he stated that he was not making as much profit as he thought he should and ascribed this to wastage in the business. The element of wastage that seemed to be of most significance to him was the need to buy new car keys frequently because keys were lost. This is the cluster of problems to the right of the model (in blue, if you are viewing this in color). After talking to sales staff, managers, lot attendants, car delivery people, mechanics, and other employees, it became obvious that the problems were much more complex than a few lost keys. There were two "vicious circles" of problem causality, where the behavior of staff in a variety of different operations was exacerbating the cash-flow problems experienced by the business. This is indicated by the heavy, feedback arrows in Figure 2. Unless the vicious circles of causality were broken, the business would continue to lose money.

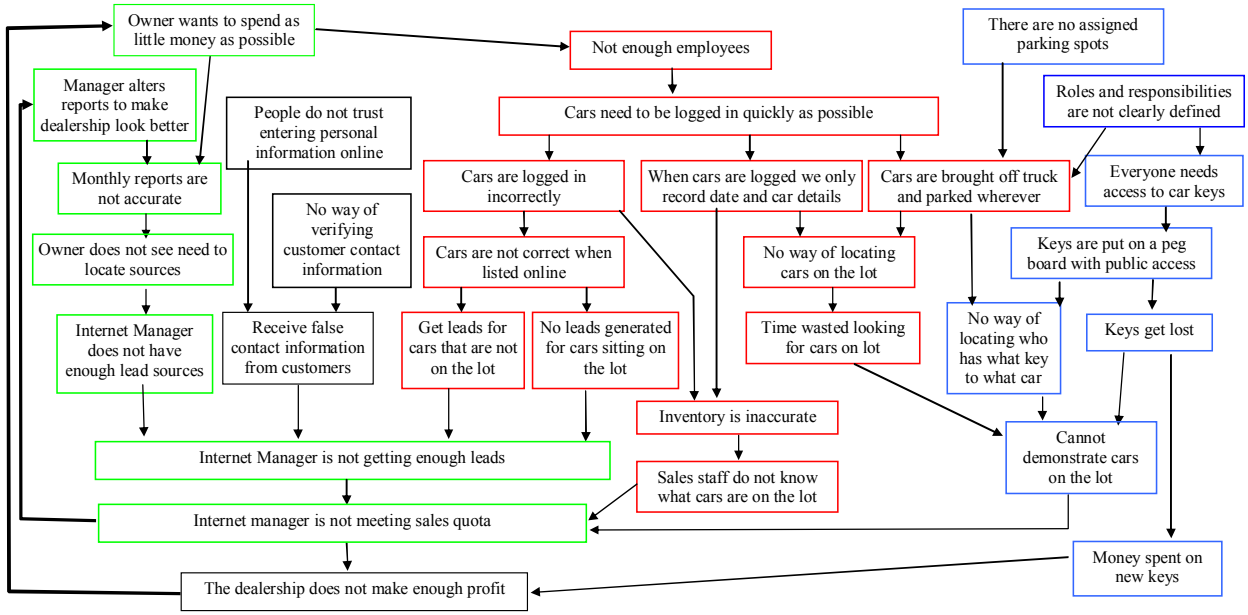

Figure 2. A Cause-Effect Model of Car Dealership Problems

4.2 Systems of business processes

The next stage was to produce a business process model: this is shown in Figure 3. The red boundary shows the scope of systems change agreed by the stakeholders involved in the co-design initiative. This proved complicated: it necessitated repeated interviews with various staff, as none of them understood what other employees did, in other parts of the business, even though they interacted with them on a daily basis.

Critical issues arose in generating the business process model, that reflect wider experience of applying the framework. The IT analysts were used to defining processes around the data processing requirements (through the production of use-cases). Organizational managers and employees were too familiar with their day-to-day work tasks and goals to conceptualize these as part of a bigger system of work. So the business process model took two iterations of process elicitation, modeling, validation, and prioritization, to produce a process model with which all stakeholder groups could agree. Modeling *business* processes appeared to be anti-intuitive and too abstract a task to understand for both the IT analyst and participant-stakeholders. Analysts were uncomfortable with the sheer scope of the processes that they were modeling, as they were trained to reduce the scope of a business to elements that are relevant to information processing with IT. It took two iterations, with guidance from an analyst experienced in systemic methods (the instructor) to achieve a breadth of scope that reflected organizational processes, rather than IT systems processing operations.

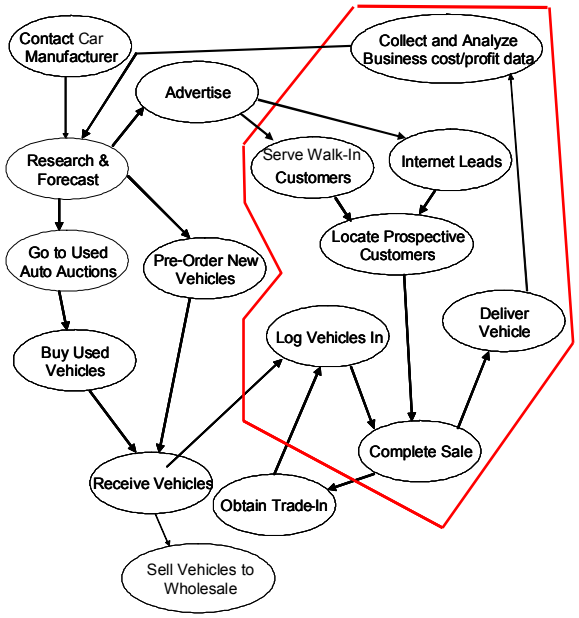

Figure 3. Business process model of car dealership

This has been found to be a common problem in applying the methodological framework. So the next element of the framework is designed to countermand the reductionist tendency and leads to enriched (wider

scope) business processes, when used in combination with the previous elements.

4.3 Purposeful systems of work practices

To counterbalance the difficulty of modeling business processes, this element of the framework integrates the *local* technological frames of various groups, by modeling the stages of human activity required to run the business [6]. Business processes are modeled as a set of workflow activities, divided into a set of swimlanes that represent different organizational functions or groups. The analysis avoids modeling process automation, focusing instead, on thinking of the entire business organization as a system that can be represented as interrelated processes that are require a flow of activities or tasks that need to be coordinated across functional groups. Managers and employees are provided with a representation that allows them to think about how work gets done, how the successful completion of work is measured, and how the coordination of work across functions may be improved [20]. This ensures that they consider the *purpose* of various systems of work-practices. If one models what people do, rather than how the information-flows work, then problems with the current system of work become apparent fairly quickly. A model for the car dealership is shown in Figure 4.

It helps to impose a rule that no automated (computerized) processes may be modeled until all of the human-activity processes have been modeled. This maintains the interpretive flexibility of the model, enabling it to act as a boundary object that is meaningful to the people performing the work tasks.

Where an automated process is shown, this is represented as a human process that is partially or completely shaded, to indicate the extent of automation. Very few processes are completely automated. This form of model requires the analyst to engage in a dialog with actors about how they would like to use information technology. This stimulates learning across actors and stakeholders about the ways in which information is used by others and the consequences of recording, or not recording information, leading to productive breakdowns in which they redefine their collective understanding of how the various systems of work interact. If they debated in a meeting of stakeholder representatives, the findings of this element of the analysis often result in changes to what information individuals decide to record, regardless of whether a computer-based information system is implemented.

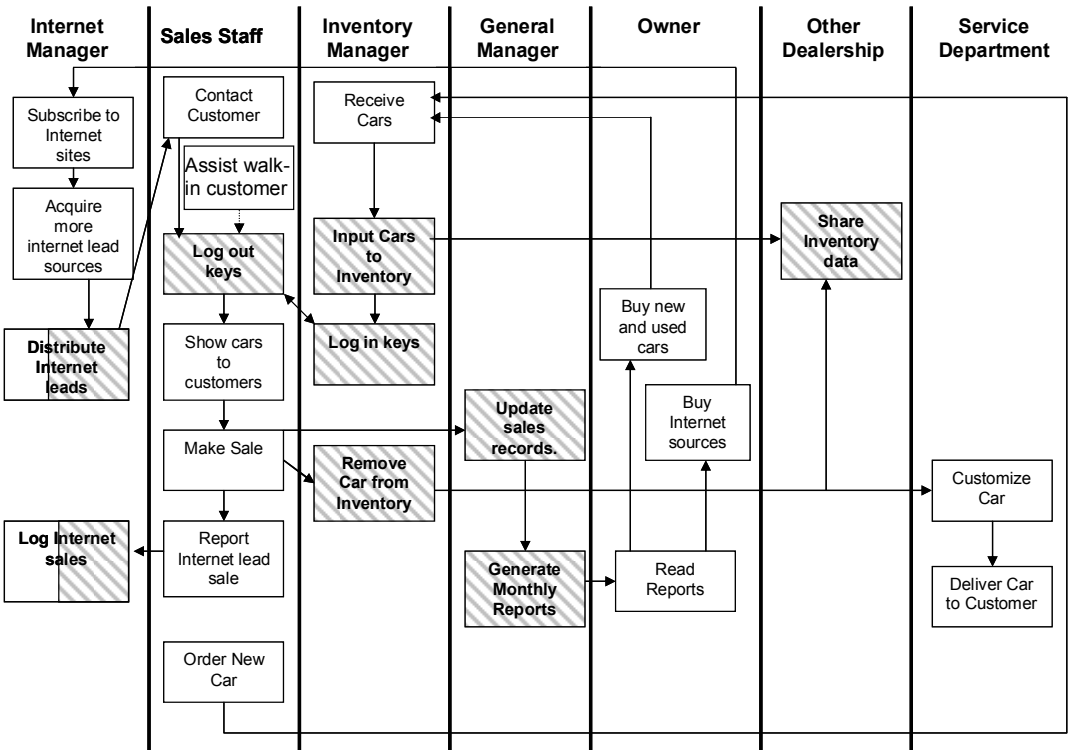

Figure 4. Human-activity & automation swimlane model of business processes (shading indicates automated processes)

Initially, IT analysts find this approach to be anti-intuitive, as it breaks many rules of formal data-processing models. Activities must be completely "joined-up", so that human processes are privileged equally with computer-based data-processing. Information-flows can appear to originate from a data-store, because the availability of information triggers a time-delayed process. This was resolved by use of a notation that converts the data-store entry into a "record information" process, and so avoids modeling data-stores.

In the case of the car dealership, production of the swimlane model enabled the IT analyst to return to the business process diagram (Figure 3) and to fill in the blanks. Unlike the initial attempt to validate this with staff, people who worked at the car dealership were able to contribute helpfully in validating the higher level business process model and in suggesting a potential boundary for systems change.

4.4 Stakeholder change requirements for the supporting systems of IT

The fourth representational perspective incorporated in the framework requires a stakeholder analysis, that focuses on *how IT supports (or could support) stakeholders in their work*. I have found that IT analysts, particularly those with most professional experience, will not engage fully with stakeholders in producing this analysis. Instead, they prefer to produce an "analysis" based on their own understanding of what each stakeholder wishes to change. Requiring the analyst to validate what actions should be taken to meet their goals with each stakeholder produces a much richer set of goals for change – and leads to a "ready made" set of requirements for the new information system, that allows validation of the purposes of the work-practices modeled for the swimlane analysis. A sample is presented in Table 2.

Table 2. Stakeholder analysis for the car dealership changes

Goal (of personal work)	Impact of achieving goals	Strategies to achieve goals (including systems change)
Dealership Owner		
B. Wants to spend as little money as possible.	By spending less money he can put more in his pocket.	Don't improve anything; however, he could spend a little now to make a lot later. This **conflicts with every proposed improvement.**
A. Wants to make as much money as possible.	By making as much money as possible he can put more money in his pocket	Need to make improvements so that he can increase sales. This **conflicts with his first goal** but we assume if he spends a little to make a lot he would be happy.
Internet Manager		
B . Would like to acquire more internet lead sources.	This will help acquire more actual leads which will lead to more sales.	Sign up with more internet sites; this would cost money; so **conflict with owner's goal** of not spending money.
B. Wants to distribute the leads among sales staff fairly.	Sales staff would all receive fair share of leads which leads to happier staff.	Have only one person (the Internet Manager) distribute leads based on a rotating schedule of the sales staff. **Possible conflict with GM** distributing/taking leads..
B. Wants to have the internet leads handled promptly by sales staff.	Customers more satisfied with service. Could lead to more sales which would lead to more income.	Set up a lead monitoring system where the Internet Manager gives a lead to a staff member and they report back on the status of a lead. May require some system set up so is a **possible conflict with .owner**
General Manager		
A. Would like have an accurate inventory of all the cars at the dealership.	Sales staff will know what cars are on the lot for sale. Will provide higher cust. satisfaction & sales	Have only the Inventory Manager and one other person update the actual records for the dealership inventory. Pages can fall out so more sturdy record system needed.
C. Wants to get as many sales as possible.	GM makes more money and is happier.	He could spend more time out on the sales floor and let someone else handle his phone. This would **conflict with the Sales Staff** wanting to get more sales.
Sales Staff		
B. Want a fair internet lead distribution.	With more internet leads they have more possible sales and can then make more money.	Set up a lead monitoring system where the Internet Manager gives a lead to a staff member and they report back on the status of a lead. This might require some system set up so there is a **possible conflict with owner**.
B. Want to make as many sales as possible (get more ups).	Making more sales makes them more money. Have happier sales staff.	They would have to keep a look out to get as many customers as they come in the door. Have the GM stop taking ups and internet leads. **Conflict with GM**.
Customers		
B. Want to pay as little for a car but get the most for their money.	This will lead to happy customers who would spread good word of mouth to increase sales.	Updating the pay structure will benefit the customer because then sales staff can offer more accessories which gives the customer a good deal. **Conflict with owner.**
B. Would like prompt replies when they send in their contact information.	This will lead to happy customers who would spread good word of mouth to increase sales.	Internet lead tracking can ensure that customers are handled promptly.

This also has the advantage of providing grounds for the "mobilizing vision" of process and system change. I have observed that discussion of the changes prioritized by each stakeholder tend to lead to productive breakdowns, resulting in a deeper, consensus understanding of how the various parts of the business process system interact. Then conflicts between various stakeholder change requirements are assessed (these are shown in bold type in the strategies column of Table 2). It is the task of the business owner or senior management to determine how these should be resolved. This part of the process – the ranking and discussion of tradeoffs between changes – provides a mobilizing vision to guide the implementation of the first cycle of change. Following these changes, the models produced as a result of applying the framework presented here provide a way of benchmarking the results of the changes and suggesting a new mobilizing vision for the next cycle of change.

5. Conclusions

The framework presented in Table 1 treats the co-design of business and IT systems as a wicked problem, possessing interrelated and often conflicting systems of problem perspectives [19]. A method to resolve such problems must surface implicit knowledge and reconcile conflicting or competing perspectives of change goals and requirements. The perception of whether an organizational information system "works" or does not "work" depends upon the point of view represented in the model, which in turn affects how problems are defined and articulated as the basis for change. Maintaining the equivocality of design knowledge across multiple cycles of analysis is critical to this objective. It allows goals to emerge, reducing the mismatch between the design method and the expectation that goals will drive the co-design of business and IT systems – even when these goals are unclear. The approach therefore relies on cycles of iteration, where multiple perspectives of the organization are constantly compared for internal consistency (a key criteria for design closure) at both global (boundary-spanning) and local (workgroup-specific) levels of analysis. It incorporates an analysis of emergent business processes, wicked problems, local systems of purposeful work practices, and their supporting systems of IT.

The design approach is intended to maintain *interpretive flexibility* [3], where the role, purpose, and forms of technology and procedural change are kept open across multiple cycles of modeling, analysis, and debate by various groups of stakeholders in the design. I have presented examples of how breakdowns in assumptional knowledge were introduced by a comparison between the organizational perspectives modeled. Collective breakdowns led to increasingly sophisticated interpretations of boundary-spanning requirements for the co-design of business and IT systems, as more complicated and informed knowledge-frameworks replaced prior assumptions about how the organization worked.

Within the space constraints of a short paper, I have attempted to explore the role that various types of boundary object play in mediating distributed understanding and knowledge. Technological frames may be surfaced and elucidated through the production of boundary objects that integrate interpretations of the organization held by various stakeholder groups. The integration of technological frames across stakeholder groups may be progressed by the need to produce a shared boundary object for external consumption, such as a design vision document. Some types of boundary object (models & maps) may be more productive in catalyzing dissonance between groups, causing a collective form of the breakdowns hypothesized by Winograd and Flores [23] to be productive. The representations employed here achieve the surfacing and exchange of complex knowledge across group domain boundaries simply because they employ model or map type boundary objects that facilitate knowledge translation [5] and are, at the same time intelligible to non-technical stakeholders (with a little explanation). It has been demonstrated that a collective breakdown can be productive under these circumstances, as it forces stakeholders from various functional groups to reconcile and integrate contradictory technological frames. This results in improved collective models of the organization, an increased understanding across groups of their common purposes, and the production of an aligned set of goals for change [18].

It was argued that we need new methods to support the effective co-design of business and IT systems in a mutually constitutive way. The analysis framework and the study presented here demonstrated how a "common language" may be employed to integrate group knowledge about the ways in which people need to work across diverse functional groups. Employing this framework resolves the five problems of IS design [10]. It resolves the *design problem* by integrating the conceptual and social processes of IS design. The framework requires a process that cycles between the giving of form to a set of process changes that relate to specific problems of emergent knowledge processes, and the implementation of that form by relating global problems to local purposes of work and how these are supported by IT system changes. In turn, these changes are related back to support for global business processes. It resolves the *process problem* by treating change requirements as emergent. The cyclical

process compensates for the "opportunistic" framing of technology by IS professionals, as they are faced with the consequences of their design choices in subsequent cycles. It resolves the *framing problem*, by explicitly focusing on tradeoffs between global vs. local, and work-practice vs. technology elements of the wicked problems pertaining to emergent knowledge processes. It resolves the *teamwork problem* through hermeneutic circle of integration, where global knowledge is tested against local knowledge of how to work, which in turn is integrated across organizational groups to design effective business processes. Finally, it resolves the *context problem* by evaluating technology optimization explicitly against criteria for change that derive the situated context of global, wicked problems and the local, socio-cultural practices of work.

This study presented a conceptual and pragmatic framework for integrating technological frames across stakeholder groups, to provide them with a common language for the co-design of business and IT systems. The contribution of this paper is to demonstrate how interpretive flexibility may be maintained across cycles of discovery and analysis, so that all stakeholder perspectives may be privileged equally in IS design.

6. References

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