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Sean T. McGann

Ohio University College of Business, mcgann@ohio.edu

Kalle Lyytinen

Case Western Reserve University, kjl13@case.edu

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The Improvisation Effect: A Case Study of User Improvisation and Its Effects on Information System Evolution

Effet de l'improvisation : Une étude de cas de l'improvisation de l'utilisateur et de ses effets sur l'évolution du système d'information

Completed Research Paper

Sean T. McGann

Associate Professor of MIS
Ohio University College of Business
mcgann@ohio.edu

Kalle Lyytinen

Iris S. Wolstein Chair
The Weatherhead School of Management
Case Western Reserve University
kjl13@case.edu

Abstract

Few studies have examined interactions between IT change and organizational change during information systems evolution (ISE). We propose a dynamic model of ISE where change dynamics are captured in four dimensions: planned change, improvised change, organizational change and IT change. This inductively-generated model yields a rich account of ISE and its drivers by integrating the four change dimensions. The model shows how incremental adjustments in IT and organizational processes often grow into a profound change as users improvise. We demonstrate the value of the dynamic model by illustrating ISE processes in the context of two manufacturing organizations implementing the same system over a study period of five years. This paper makes its contribution by holistically characterizing improvisation in the context of IT and organizational change. Our ISE model moves research in organizational and IT change towards a common framing by showing how each affects the other's form, function and evolution.

Keywords: Improvisation, organizational change, information system evolution, longitudinal multi-site case study

Résumé

Peu d'études ont examiné les interactions entre le changement des TIC et le changement organisationnel lors de l'évolution des systèmes d'information (ISE). Nous proposons un modèle dynamique de ISE où les dynamiques de changement sont capturées selon quatre dimensions: changement planifié, changement improvisé, changement organisationnel et changement des TIC. Notre modèle ISE déplace la recherche sur le changement organisationnel et sur le changement des TIC vers un cadre commun en montrant comment chacun affecte la forme, le rôle et l'évolution de l'autre.

I. Introduction

Few studies have examined interactions between Information Technology (IT) and organizational change while information systems¹ (IS) evolve. The significance of such evolution, defined as a process where systems “undergo continued progressive change in some of their attributes, which leads to improvement in some sense, and often to the emergence of new properties” (Lehman 2003) has been recognized in past software research (Lientz and Swanson 1978). Information Systems Evolution (ISE), however, goes beyond software change and embraces processes of generating new IS requirements from organizations and users; in response dynamically adapting organizational routines and software capabilities. Specifically, we define ISE as an iterative process of punctuated, transformative changes in organizations and its information systems that result from planned change actions by organizational implementers and incremental improvisations by users. Though earlier research has identified a plethora of management issues related to software evolution, we see a paucity of studies of how software change interacts with organizational change, especially those that focus on the role of users in this evolution and how this evolution can be managed.

In this paper we seek to fill this gap by probing the following:

1. How do changes in organizational routines and IT interact during Information System Evolution (ISE)?
2. How do users’ improvisations generate permanent changes in organizational routines and IT designs (i.e. modifications and enhancements)?

Our paper will make two contributions: 1) it advances ISE research by examining reciprocal relationships between users’ improvisations and planned organizational and IT change. 2) it augments improvisation research by considering dynamic interactions between planned organizational change and IT design during the ISE process. The paper is organized as follows: we will first discuss software evolution, organizational change and IS improvisation. Thereafter a dynamic model of ISE is proposed. We then apply the ISE model to analyze two empirical vignettes of ISE in order to illustrate how user improvisations propagate large-scale change. The paper concludes with a discussion of major findings and suggestions for future research.

II. Related research

Software Evolution

The evolutionary nature of software has been recognized in software research for decades. In this context it has been observed that software maintenance cost- especially software enhancements and modifications- account for up to 75% of the total cost of the software (Lientz and Swanson 1978). Moreover, software evolution, is “inevitable, since changes generated by business policies and operations need to be propagated onto the support software system” (Wan Kadir 2004). Yet, a review of the extant literature shows that antecedents to this change remain poorly understood (Lehman 2003). Previous studies mainly articulate internal dependencies in software that influence its evolution and define a process to manage it. Extant research also identifies a set of antecedents in the environment including new business rules (Wan Kadir 2004), fluctuation, and changing user preferences (Lientz and Swanson 1978). However, being solely software focused, it fails to recognize reciprocal and mutually constitutive interactions between software and organizational change. Therefore, we argue that the IS field is better positioned to marshal studies which analyze software change and organizational change holistically and thereby provide more systematic accounts of ISE.

^{1 1} The term information system (IS) is defined in this paper as the system that integrates BOTH organizational work routines and information technology to create a socio-technical system (STS).

Nature of Organizational Change

Organizational change and software change are inextricably linked and mutually constitutive. This claim underpins socio-technical theory, which conceived any organizational system to contain both social and technical elements while their change is open to triggers from within and without (Trist et al 1963). Socio-technical theory integrates IT and organizational change by viewing them as a cascading chain of events that traverses through both technical and social elements of the organizational system. From this perspective, the key in designing an information system is to strike a balance between users and IT elements (Applebaum 1997) while appealing to a list socio-technical ideals (Majchrak 1997).

ISE as socio-technical change is predicated on an emergent view of change (Mintzberg 1985). When using the emergence lens, ISE is said to be driven by improvisation- bricolage- that accumulates over time into transformative socio-technical change. Such a change embraces both organizational routines (Feldman 2000) and IT elements. This is in line with Orlikowski's (1996) definition of organizational transformation as: "emerging out of actors' accommodations to and experiments with everyday contingencies, breakdowns, exceptions, opportunities and unintended consequences that they encounter"(Orlikowski 1996). This view can be contrasted with the traditional model of organizational change (Hage 1965), where actors deliberately initiate change in response to opportunities and technological imperatives (Leavitt and Whisler 1958). Most IS development approaches view IT change by appealing to this traditional planned change model (Hirschheim et al. 1995). In contrast, the emergent view of IT change is less developed Morch 1995; Orlikowski 1996). Orlikowski's emergent analysis, however, does not address the issue of how user improvisations lead to concomitant changes in the IT designs, and thus become "reified" and institutionally transformative. Therefore, we will next integrate both views of ISE and analyze it as a joint outcome of both *improvised change* and *planned change* that integrates both the *IT* and *organizational/process aspects of change*. This distinguishes four classes of change associated within ISE as shown in Table 1.

Table 1 – Four Change Dimensions

	Planned Change	Improvised Change
Organizational/Process Change	IS Implementation/Work Routines (Mintzberg 1985; Feldman 2000)	Process Workarounds (Orlikowski 1996; Weick 1998)
IT Change	IT Design and Development (Hirschheim/Klein and Lyytinen 1995)	IT Workarounds and Configured Improvisations (Morch 1995); Orlikowski 1996)

III. Theoretical Framework of ISE change

IS Improvisation Types

Past IS improvisation research distinguishes two categories of IT related improvisation. First, improvisations can result from shortcomings or “functional gaps” in the existing IS- normally denoted as *workarounds*. Second, improvisations can result from a user seizing new opportunities to configure existing IS capabilities into new functionality- known as *configurable IT improvisations*. The first type of improvisation is caused by unanticipated “exceptions” during use, which create new requirements on the fly. These exceptions consist of use cases that the IS cannot process correctly without human intervention (Strong 1995); or of events for which no applicable rule exists (Saastamoinen 1995). The scope of exceptions covers: 1) erroneous or incomplete input, 2) requests to deviate from standard procedure, or 3) situations that the system was never designed to handle (Strong 1995). Such exceptions are caused by: 1) operating errors (user error), 2) design errors (design flaw or a missed requirements), and 3) uncontrolled change. Exception handling involves identifying the exceptional event and selecting pertinent action to set the system back to a coherent state (Saastamoinen 1995) by inventing workarounds, i.e. “intentionally using computing in ways for which it was not designed, or avoiding its use and relying on an alternative means of accomplishing work” (Gasser 1986). The second improvisation type involves changing the system configuration to meet unanticipated user requirements by using tailorable technologies that allow for modification and adaptation (Mehandjiev 2000). Such configurable improvisations emerge in response to new requirements when an existing application is inadequate to handle it (Morch 1995).

Accordingly, these two dimensions can be utilized as follows to classify improvised changes carried out by the user:

- 1) **Nature of improvisation:** “Configured Improvisations” when the new requirements can be met with the designed system tailorability vs. “Workarounds” when the system fails to satisfy the current user requirements with the designed functionality, and
- 2) **Target of improvisation:** Improvisations consisting of an *adjustment of a process* vs. those that are an *adjustment of the IT*. With those characteristics we can propose the following classification scheme for types of improvisations (see table 2):

Table 2 – Improvisation Types

Improvisation Type	Process (Weick 1998)	IT (Orlikowski 1996)
Configured (Morch 1995)	<i>Configured Process Improvisation</i>	<i>Configured IT Improvisation</i>
Workaround (Gasser 1986)	<i>Process Workaround</i>	<i>IT Workaround</i>

Four improvisation types in the context of ISE can thus be defined:

1) Configured Process Improvisation² – a dynamic modification of an information system use process facilitated by the existing system functionality. This promotes agile responses to changing system requirements by rapidly developing new use processes. An example would be to change the order entry process by changing task sequence or actor responsibilities.

2) Configured IT Improvisation – a dynamic modification of IT that is facilitated by existing system design functionality. This promotes agile responses by re-configuring the IT system to meet the new requirements. An example would be selecting from options in a system configuration menu of a supply chain system, which allows the user to control the unit of measurement for materials (pounds, ounces, grams, etc).

² No improvisations of this type were found in our case studies, so no examples are presented. Therefore, the validity of this improvisation type remains to be seen.

3) IT Workaround – an adjustment in the use of an IT, which involves intentionally using it in ways it was not designed. This promotes agile responses to new requirements by using existing system functionality differently. An example would be to use a comments field to store the vendor’s version of a part number.

4) Process Workaround – the creation of temporary organizational processes in response to an unmet IT requirement. This promotes agile responses to new requirements by changing a business process on the fly. An example would be planners mailing schedules to suppliers because they were unable to access them due to system problems.

Improvisation Scale

The idea of a scale of improvisation was characterized by Weick (1998) as a continuum ranging from “interpretation” (taking minor liberties and adding accents), through “embellishment” (anticipating, rephrasing and regrouping) and “variation” (adding clusters not originally included), which results in full-scale “improvisation” (transforming until there is little resemblance to the original artifact). Weick describes how any improvisation episode may fall anywhere on this scale. Those that are “full-spectrum improvisations” have made it through the complete process and are apt to be more pervasive, diffuse faster, and become more permanent. This provides a basis for analyzing how improvisations associated with IS use vary over time thus creating a continuum for analyzing the scale of changes during ISE. A similar improvisation continuum was applied in Orlikowski’s (1996) study where she characterized improvisations during IS implementation processes to range from ad hoc “situated changes” (called “embellishments” by Weick), to long-term changes denoted as “metamorphoses” (Orlikowski 1996) (Weick’s “full-spectrum” improvisations).

Information System Evolution Stages

By combining the improvisation types, scale and the four ISE change dimensions, we can next formulate an extended, dynamic model for ISE (see Figure 1). The model recognizes four stages of ISE change: 1) ad hoc adjustment, 2) embellishment, 3) modification and 4) metamorphosis. It also clarifies how a temporary adjustment in IT use or a related organizational process can ultimately evolve into an organizational transformation. We propose the following definitions for each type of stage of change during ISE:

1) Ad Hoc Adjustment (IT or Process) – An initial stage in the ISE. During this stage, a user creates a solution for a new requirement by producing an IT or process workaround, or a configured improvisation. The improvisation remains localized, and does not result in formal modifications of IT, or organizational routines. Most of these improvisations do not cause further modifications due to the sporadic nature of the unmet need. Consider the following example: A custom query was developed to uncover purchase order lines in the supplier portal that did not match with those in the legacy system. This was used infrequently, as it was developed to meet an unusual requirement.

2) Process Embellishment – This stage results from an ad hoc process improvisation, which has been extended to change standard organizational routines. The magnitude of the organizational impact of an individual embellishment is typically not significant. Consider the following example: Material handlers needed to use material information before it was entered into the ERP system. One user improvised a process of leaving a note on the receiving clerk’s desk with all pertinent information about material, if it was taken before the data was entered. Thus a formal routine was created and a log was designed to be filled out for later system entry if materials had been taken prematurely.

3) IT Modification – This stage results from an ad hoc IT improvisation being permanently designed into new IT functionality. Consider the following example: one key supplier user needed in-transit information for her overseas warehouses, so she improvised a query and spreadsheet system to handle the requirement. Management became aware of this new report function and decided to modify the existing inventory “pull report” so that it now could calculate and display in-transit information on all shipments.

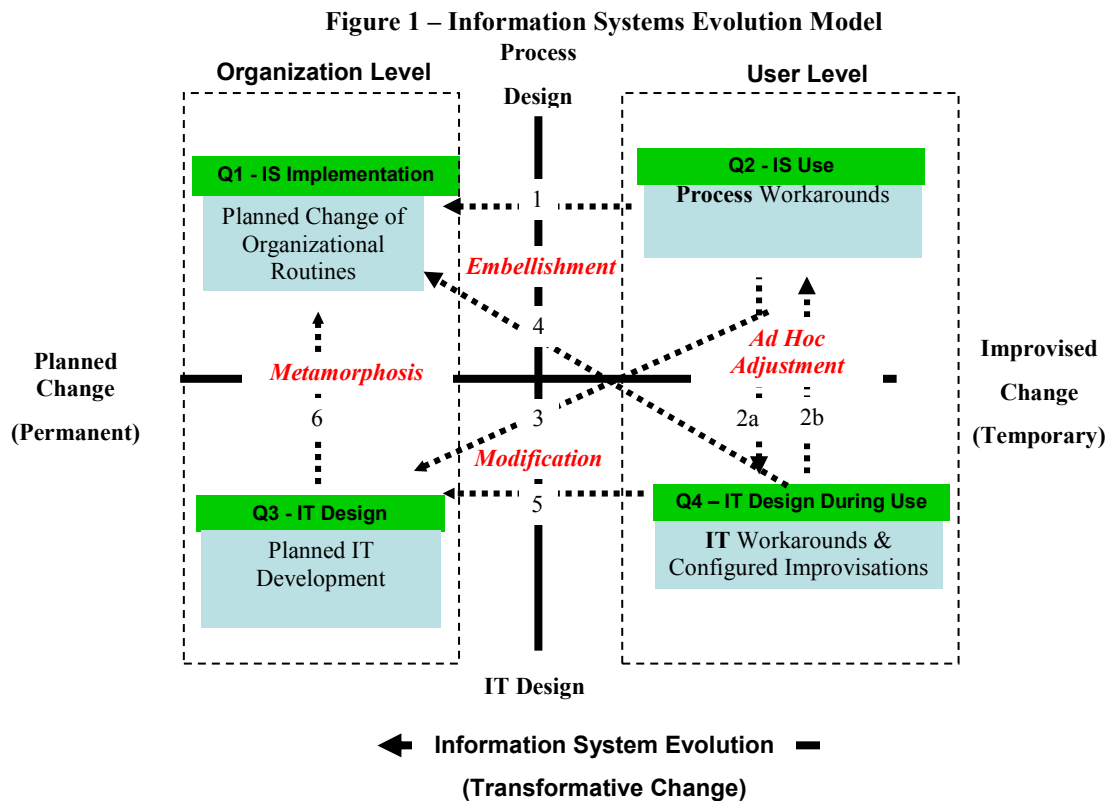
4) Metamorphosis – This is the “final” step of our ISE process. It consists of a combination of one or more significant modifications of the IT design and one or more process embellishments. The overall impact of this change is deep, as organizational procedures, IT designs, job definitions and use policies are all changed. Consider the following example: The current supply chain strategy was to focus on having vendors manage the inventory control process. This required them to automatically replenish supplies at chosen inventory trigger points. A number

of inconsistent processes and IT reports were improvised at various plants to accomplish this. The decision was made to leverage the power of the studied portal system to make it a more efficient and consistent process. As a result, an entirely new software module and set of formal processes were created and implemented with associated organizational changes.

A dynamic analysis of the succession of stages of ISE forms an important task in creating a more comprehensive view of ISE, which integrates IT change and organizational change into a single dynamic model. The model shows how minor user improvisations can grow into path-breaking organizational changes. The model also suggests that to do so, improvisations must be “cultivated” through an ongoing process of refinement, extension, and institutionalization.

Dynamic ISE Model

We can now propose a dynamic model of Information Systems Evolution (see figure 1). The model illustrates interactions between organizational and IT changes and how they evolve into organizational transformations, as improvisations scale up during the ISE process.



The model identifies four quadrants that characterize key areas of change during ISE. Initially, in Q1- the quadrant of planned organizational processes and structures- rules for organizational routines- are created in a planned mode through business process design. These are combined with the design of an organization’s information technology services in Q3, by designing information systems that meet the requirements set up by organizational structures and processes designed in Q1. The designed IS artifact is instantiated (or appropriated) in Q2 during the use process by users who leverage IT to enact organizational routines. As our data and other studies (Orlikowski 1996) show, when IS use transpires over time, users will improvise locally. This is defined in the model as an incremental change either towards IT in Q4 (i.e. IT workarounds and new configured IT artifacts that are improvised during use), or towards

new routines in Q2 (i.e. process workarounds) while users adjust their routines to new or unrecognized needs in the organization's environment. Influenced by multiple contextual variables and triggers, these improvisations can facilitate or trigger other improvisations along paths 2a and 2b, or they can evolve into incremental changes in routines in Q1 along paths 1 or 4, or IT design in Q3 along path 3 or 5. Under certain conditions, as incremental changes along paths 1 or 4 (embellishments) and paths 3 or 5 (IT modifications) accumulate, they can trigger a deeper organizational transformation in both planned IT designs and routines along path 6. We refer to this transformation as a metamorphosis. Organizational structuring shifts along path 6 represent a significant "punctuation" in the ISE process and set the stage for another iteration of the ISE process, which begins again in Q1. The model and its stages are summarized in Table 3 below:

Table 3 – ISE Stage Summary

Evolution Stage	Level of Change	IT/Process Design	Planned/Improvised Change	Stage Summary
Ad Hoc Adjustment (Paths 2a & 2b)	User	IT or Process	Improvised	<ul style="list-style-type: none"> Users improvise with organizational routines or IT as a result of unmet requirements.
Process Embellishment (Paths 1 or 4)	Organization	Process	Planned	<ul style="list-style-type: none"> IT or process improvisation results in permanent change in organizational routine.
IT Modification (Paths 3 or 5)	Organization	IT	Planned	<ul style="list-style-type: none"> IT or process improvisation results in software functionality modification.
Metamorphosis (Path 6)	Organization	IT and Process	Planned	<ul style="list-style-type: none"> Accumulation of Process Embellishments and related IT Modifications result in significant information system transformation.

Overall, the model offers a baseline for comprehensive and dynamic analysis of ISE. It integrates all change dimensions (planned, improvised, IT and organizational) and stages of change (ad hoc adjustment, embellishment, modification and metamorphosis). Having formulated this model, we will next illustrate its use in two cases where we explored how two inter-organizational systems evolved in use over a 5-year period. Through this analysis, we answer our research questions concerning ISE and illustrate the role of improvisations and their scale during ISE. In particular, we will deploy empirical data to illustrate interplay between planned (Q1 and Q3) and improvised change (Q2 and Q4), and use it to assess the scope of permanent change that resulted.

IV. Case Studies

Research Setting

We examined ISE longitudinally in two manufacturing organizations that implemented the same inter-organizational system over a period of five years. The system, “XXX”- an extranet-based package- leverages the Internet and portal technology for information exchange and collaboration within the supply chain. The package is developed by Express, a small software development/consulting firm located in northwest Ohio, which specializes in developing Internet-based eCollaboration solutions.

The XXX package was first implemented by Big Brake Company (BBC) a manufacturer of OEM and aftermarket brake assemblies and replacement parts for large commercial trucks, and Automotive Interior Manufacturer (AIM), a Japanese-owned company, with only one customer: Honda. They manufacture seats and other plastic injection-molded parts for several Honda models. Both companies are middle-market (approximately \$500 million in annual revenue), operate as Tier 1 suppliers, have small IT staffs (less than 10 personnel) and saw XXX as an important strategic direction for the future of their organizations.

Method

We combined theory building (Glaser and Strauss 1967) and case studies (Yin 1984) with process research (Langley 1999). We chose the case approach because the study involved the examination of a complex social phenomenon and we had a need to “retain holistic and meaningful characteristics of real-life events” and “retain contextual conditions” (Yin 1984). The approach also allowed for the use of multiple data sources to increase validity of findings through triangulation (Yin 1984). Our research method models Eisenhardt’s (1989) approach and therefore involves both theory generating and validating elements. Process research methods, especially tracking down improvisation event sequences, (Langley 1999) were used because we were theorizing about processes. Specifically, we were looking for an explanation of how and why events related to ISE progressed and what types of changes and transformations took place. We observed that the research questions related to ISE required an extended observation timeframe to be able to observe complete ISE evolution cycles related to figure 1. Therefore, a five-year timeframe was selected (4/03-3/08). The choice of a longitudinal approach strengthened external validity and reliability of the study. The research design significantly extends the time/scope of research design when compared with earlier improvisation studies. For example, Bansler (2003) studied a single system implementation over six months, while Orlikowski’s study (1996) covered two-years, but was limited to pre- and post-implementation interviews within one organization.

Data Collection and Analysis Approach

We collected data related to system use, improvisation, system changes and related events through formal and informal interviews, passive observations of meetings, training, participant observation where we interacted with the system (such as performing A/P, receiving and purchasing transactions) and use of other ethnographic techniques (photographs and field notes). We extensively perused the system documentation (such as training materials, memos, articles and e-mails) and physical artifacts (such as issues database, reports and access mechanisms to the XXX system). The data collection followed system users, system managers, system developers and general process managers. Overall, 73 interviews were conducted. Interviews were transcribed and coded for synthesis and generalization. Interviews were communicated for interviewees for reliability and validity checks. The intent of using multiple sources of evidence was to triangulate data to increase credibility, corroborate findings and establish a chain of evidence (Yin 1984). The data analysis followed an iterative theory-building process of analysis and verification across data collection rounds using the constant comparative method (Glaser and Strauss 1967). Data collection and analysis results were repeatedly compared with new data to allow for adjustment of the evolving theoretical ISE model and revision of the data collection approach using preliminary, within-case and cross-case generalizations. The analysis of data was divided into two stages. First, during data collection and codification, we looked specifically for improvisation events, which were then categorized by improvisation type (Table 2). Second, we mapped these improvisations to the appropriate area of the ISE model (Figure 1) and followed their movement across change quadrants over time. We then used the concept of process narrative (Langley 1999) to summarize main explanation for the observed ISE process. Further details on data collection were excluded due to space limitations.

V. Findings

We use modeling (Langley 1999) to describe narratives associated with two exemplar ISE processes initiated by local improvisations. Although we observed a plethora of ISE processes, these examples show ISE processes that traversed the entire ISE model from local ad hoc adjustment to organizational metamorphosis. Each process illustrates how key constructs and their relationships are organized within the model. Specifically, the examples were chosen as they met the following criteria: 1) the ISE process reached metamorphosis, 2) they evolved either slowly or quickly, 3) the ISE impacted all main stakeholders of the system: the manufacturer and its suppliers and 4) the scope of the organizational change was among the most significant of all ISE processes in this study that reached metamorphosis.

BBC ISE Exemplar – “The VMI Process”

The management of specialized inventory at BBC underwent a significant transformation during our study period. Through the use of the web portal, user improvisations generated numerous new processes and software modules for the Vendor Managed Inventory (VMI) process. This supply chain arrangement requires suppliers to monitor BBC plant inventory levels of selected materials, and ship automatically when needed. A metamorphosis took place when ad hoc adjustments carried out through non-automated inventory communication processes (e.g. fax, phone and e-mail) and IT workarounds (e.g. new custom legacy system queries and spreadsheets) evolved into major organizational change for BBC and its suppliers. This metamorphosis pushed the XXX system through an ISE process, which resulted in the creation of the VMI system with its associated processes. During our study the system was fully developed and implemented at several BBC supplier sites, with plans for more wide-scale adoption in the future. The following quote by the Director of Supply Base summarizes the importance of the VMI model at BBC:

“Our goal all along has been to cut costs, but now we are looking to force suppliers to do their part to make this happen. This means a shift to the VMI model on as many parts as possible, setting good min/max levels and measuring suppliers by the level of success achieved. This is a new way of thinking for us and our supply base, but we are optimistic that we will save a lot of money in the process”. (BBC Interview 2003)

Initiation of ISE– VMI Reporting and Query Process: an IT/Process Workaround

Before the XXX implementation, VMI was being used on a limited basis and with little success. Transmitting demand data via EDI was working for “normal parts”. But, VMI suppliers had additional requirements for new information that their current EDI arrangement could not provide (e.g. min/max vs. current inventory levels, cumulative shipments, forecast, etc.). This information was necessary to effectively manage inventory levels. Buyers/Planners from several BBC plants had developed a variety of processes and IT support to meet the requirements of obtaining and communicating detailed information to VMI suppliers, which became part of their organizational routines (Q1 in our model). Some were querying the legacy system, printing reports and faxing them. Others had used personal spreadsheets and e-mailed them. Phone was used extensively to deal with daily exceptions. In many cases suppliers were keying the sent data into their own systems. None of these solutions was particularly effective.

According to the system liaison, problems stemmed from inconsistent systems in place across plants, the legacy system generating demand updates only weekly and not having an efficient means to deliver the information to the suppliers:

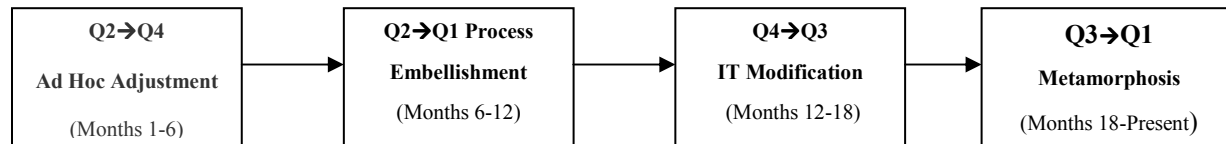
“We have a number of plants that have been attempting VMI for awhile, but it has been a messy process. People were going in different direction, which makes it tough for us to manage from here. Suppliers were getting bad information, and some had to deal with multiple plants with different processes for VMI. Since this is an important strategic process for us, we really needed to find a way to get it under control”. (BBC Interview 2003)

Evolutionary Path

The evolutionary path of improvisations related to VMI is illustrated below as it evolved over an 18-month period (Figure 2). The trace shows how local improvisations moved slowly through various phases of the ISE model

outlined above. The evolution started as an ad hoc adjustment (Q2→Q4)³ for the first six months before evolving into the process embellishment stage, which formalized the VMI process for the first time and used XXX functionality to fulfill some of the new requirements (e.g. data downloads) (Q2→Q1). After that the process stabilized. Meanwhile an extensive IT modification was designed to create a new XXX software module and associated processes (Q4→Q3). The new VMI module created the impetus for a large-scale change across the supply chain as new systems and processes were implemented at supplier sites, a new consignment strategy was developed for BBC, and a plan was formulated for the future use of the module as a Kan Ban system (“pull” system where consumption of material automatically triggers a signal to the supplier to send another shipment) using automatically generated e-mail alerts to transmit demand data (Q3→Q1). This provides an example of how an early improvisation generated a large-scale change which caused significant ISE.

Figure 2 - VMI Process Evolutionary Path



Summary

The VMI process exemplifies how a localized improvisation evolves into significant socio-technical change. The deployment of VMI had a large impact within BBC and across organizational boundaries. The ISE process was triggered by a new set of requirements that emerged locally, which led to the improvisation with reports and queries by local buyer/planners in different plants. The use of these tools created the initial momentum for change, which pushed these improvisations down the evolutionary path towards more institutionalized and formalized change. The final outcome was the creation of a new software module and associated mode of inventory operations for BBC in the form of a formalized VMI routine. This metamorphosis has now been expanded including the possibility of using Kan Ban, and providing a foundation for new types of consignment with overseas suppliers.

AIM Exemplar of ISE – “The Material Tracking and Receiving Process”

During the two years preceding the XXX implementation at AIM, one of the most significant problems they faced was the lack of shipment visibility and tracking. This resulted in significant amounts of lost materials. In their prior modus operandi there was no way to track individual shipments from suppliers to AIM inventory. This created significant problems for AIM receiving personnel and material handlers. With no visibility of in-transit material, they had no means to know whether the proper items and quantities had been shipped on time. “Once materials left suppliers, they sort of entered a black hole”, was the AIM materials manager’s description of the situation. In a lean manufacturing environment followed by AIM- which involves carrying one day of raw material and finished goods inventory- this is highly problematic, as material shortages stop production.

The problem was aggravated because transactions related to received materials were not performed accurately and on time. Once materials arrived at the receiving dock, the receiving clerk had to manually key the transaction into AIM’s ERP system. This was a lengthy process which took several minutes for each transaction. With hundreds of material shipments coming in each day, this created a constant bottleneck. The problem was compounded by the fact that the receiving clerk also had other responsibilities. As a result, she fell behind as much as three days in entering material receipts. Due to manual entry of a large number of transactions, there were significant human errors, which increased processing time. Another problem was the fact that shipment data was sent from suppliers in hundreds of formats, some of which were difficult to decipher. In fact, some suppliers did not send shipment data at all. To make matters worse, material handlers, in order to keep the line moving, were often forced to move shipments out to the production line before their receipts were recorded. In this process, these transactions were often not entered into the ERP system at all, the documents were lost, and the Accounts Payable department had no record of what materials had been received.

³ Notation such as this refers to movement between quadrants in the information systems evolution model in figure 1.

This situation in the receiving process rendered the ERP system information virtually useless as the inventory data was never accurate. As a result, material planners often had no idea what to order. Many times they had to resort to time-consuming physical counts to establish an accurate inventory position. This also caused major problems for A/P, as they were constantly on the phone trying to trace invoiced materials to decide whether they should pay for them. Large volumes of materials were never accounted for, angry vendors were not getting paid, material handlers were becoming increasingly frustrated and the receiving clerk's job was unmanageable. The magnitude of the problem is summed up by an AIM project manager as follows:

"...but I guess my point is, we knew we were having so many issues internally, with identifying where Associates were not doing their job and getting the data in the system so that accounting could do their job, it was obvious that receiving though was just not doing their job...and accounting couldn't actually pay bills, you know, these are huge issues with inventory accuracy cause you're not receiving inventory in the system. We really needed the ability to really count and project from month to month our profitability and our inventory shrinkage and all kinds of things, so we saw that as being a huge potential benefit". (AIM Interview 2004)

Initiation of ISE – Material Discrepancy Process – an IT/Process Workaround

When the senior materials director became aware of this crisis, it became his top priority. He was concerned because the list of problems associated with materials affected nearly all departments in the organization. Top management expected a better solution. Most importantly, according to a senior production manager, the situation affected AIM's ability to serve its customers:

"We run really lean and I only carry one day of raw material and one day of finished goods. If anything goes wrong in the materials process, my line shuts down and I can't serve the customer. The problems with raw material were a huge concern for me because of this". (AIM Interview 2004)

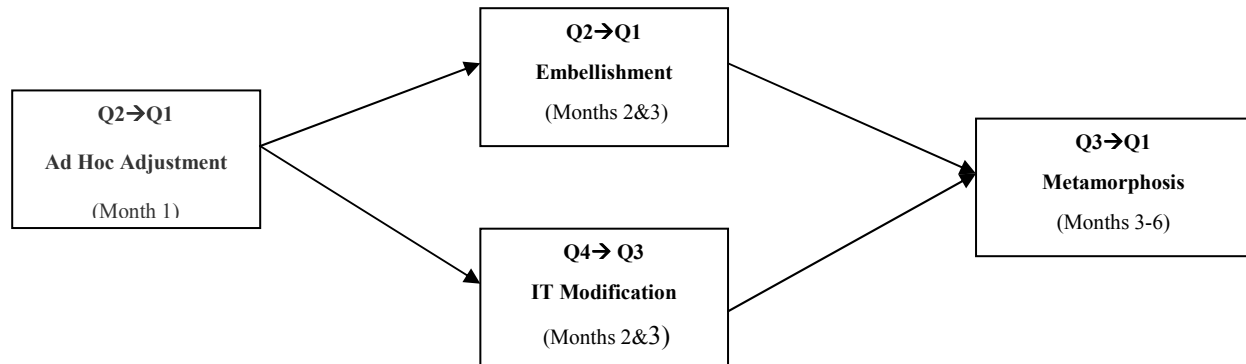
To begin the resolution process, he began to trace material flows, identifying the problem areas mentioned earlier (supplier shipping, AIM receiving, AIM material handling). He then improvised by creating an ad hoc interim tracking process and associated report called the "Material Discrepancy Log" (Q2), which was quickly formalized (Q2→Q1). This process was designed to identify lost material, so that managers could contact vendors, receiving clerks and material handlers to trace shipments and identify disconnects in the material flow. At the peak of the crisis in the summer of 2003, there were over 100 material discrepancies⁴, leaving almost 25% of raw material inventory unaccounted for.

Evolutionary Path

The path of the Material Tracking Process/Receiving Process ISE is traced below (see Figure 3). Due to the severity of the situation, the evolutionary events unfolded rapidly. The improvisation moved from an ad hoc adjustment to a metamorphosis during the first three months of the XXX implementation. It started off as an ad hoc adjustment for one month, while managers experimented with alternative temporary tracking processes (Q2). Next, in order to save time, stages of modification (Q4→Q3) and embellishment (Q2→Q1) proceeded in tandem. This yielded a new XXX software module and associated new processes for supplier shipping and AIM receiving. The receiving module carried with it the necessity for significant change across the supply chain: suppliers were now required to complete shipping transactions through the portal, in order to give instant visibility of their shipments to AIM (Q3→Q1). They were also required to print out and attach a standardized master packing list to all materials. The standardized master packing list was then scanned by a receiving clerk upon delivery, thus cutting transaction time down from minutes to seconds. This allowed prompt and correct movement of materials to the shop floor. This process also gave A/P visibility to all shipments in their ERP system, because shipments and ERP data were synchronized daily through an interface. This visibility assisted with the payment tracking processes. This provides an example of how an improvisation, which is designed to meet an urgent need, can quickly escalate into a large-scale change.

⁴ Material discrepancies are identified as shipments of material that were not accounted for on the system.

Figure 3 – Material Tracking and Receiving Process Evolutionary Path



Summary

The metamorphosis of the Material Tracking and Receiving Process shows how an urgent set of requirements trigger improvisations, which can evolve into a metamorphosis in a short timeframe. At AIM, the threat that the lost or unaccounted material posed to the company motivated management to improvise an interim solution, and to execute a complete transformation of the supply-side material management process. During the ISE new organizational routines and IT designs were planned, job descriptions and performance measures were modified, and the company's relationship with its suppliers changed. The transformation resulted in a significant evolution of the XXX system, as the existing shipping module had to be modified and an entirely new receiving module had to be created. The case serves as an example of how frequent improvisation accelerates ISE, thus establishing a solid connection between the scale of improvisation and the pace of the ISE process.

VI. Discussion and Conclusion

The key findings of this study center on the interplay between IT and organizational routines, and planned (Q1 and Q3) and improvised change (Q2 and Q4) in the ISE process. We now present these findings in the context of our research questions.

Question 1 - How do changes in organizational routines and IT interact as a part of information system evolution? We found that organizational routines and IT, which are designed through a planning process in Q1 and Q3, will evolve when instantiated in Q2, as users improvise with processes in Q2 and with IT modifications in Q4. This was demonstrated in both cases where user improvisation served as the catalyst for change in both IT and organizational routines. These changes (in Q2) often resulted in changes in IT designs in Q4, while the new processes necessitated matching IT workarounds or new IT configurations. We also observed a reciprocal effect, as IT improvisations in Q4 accelerated process improvisations in Q2. Although this interplay between organizational routines and IT in the improvised change realm was important for ISE, we discovered that improvisations must “cross-over” to the planned change realm in order to cause information systems to evolve significantly and permanently.

Question 2 - How do users' improvisations result in permanent changes in organizational routines and IT designs (modifications and enhancements)? We found that, in response to user improvisation in Q2, localized changes in organizational routines and IT designs generated permanent changes. In both cases, we saw process improvisations result in permanent changes in organizational routines (Q1), when management saw their value. More significantly, we saw how improvisations with processes (Q2) and/or IT designs (Q4) could escalate to large-scale change. We identified multiple instances where a small improvisation resulted in revamping an entire information systems area. This movement back into the planned change arena affected Q3 and Q1 simultaneously when modifications and metamorphoses followed.

The application of this model enabled us to effectively address our research questions and we can now generalize these claims with regard to the possible causes of ISE as follows:

1) *Information Systems will evolve on a limited basis, if the planned change or improvised change takes place in isolation.* In contrast, when changes cascade dynamically between the planned and improvised changed arenas, the speed, scale and permanence of the ISE is more significant.

2) *ISE necessarily involves organizational and IT components and their interactions.* Though single evolutionary events can be attributed solely to IT (modifications) or organizational elements (embellishments), these changes interact strongly during the ISE process. In addition, though embellishments and modifications can individually cause ISE, they primarily occur in tandem and, when combined, they increase the ISE scale and scope.

3) *User-level improvisations are critical and can drive large-scale metamorphoses during ISE.* User improvisations can instigate the creation of entirely new IT and organizational functions and/or processes.

4) *User improvisations do not result in significant ISE unless they move into the planned change realm and become a permanent part of organizational routine and IT design.* This demands managers' recognition of the importance of improvisation and their continued sponsorship of users' change initiatives.

Our study complements earlier research on ISE by providing a socio-technical view of the ISE process. It shows that: 1) systems evolve by the design and instantiation of organizational routines and software, 2) IT change and organizational change are inextricably linked and mutually constitutive, 3) information systems can evolve through multiple change paths and 4) incremental improvisations by IT users drive ISE. This study also expands improvisation research in significant ways. First, it provides a more comprehensive taxonomy of improvisation related to ISE as it integrates changes both in organizational routines and software. This goes beyond Weick's (1998) definition, which solely focused on variation in organizational routines (Q2). It also integrates IT design into improvisation research by showing how improvisations in the use process (Q2) evolve into major changes in organizational routines and software design (Q1 and Q4). This provides additional insights into ISE analysis, which are not present in Orlikowski's (1996) characterization of IS improvisation that focused on transitions from user-level process (Q2) to changes in organizational routines (Q1). Though she describes a metamorphosis stage in the ISE, she does not account in detail necessary transitions that took place in the preceding IT design space as improvisations evolved into software changes (Q3 and Q4).

The study has obvious limitations. First, the results are subject to the methodological limitations of a multi-site case study- we do not claim statistical generalizability. Second, while studying improvisation events, we were forced to rely on users' accounts of their improvisations and their ability to identify them. Limited recollections, difficult-to-understand terminology, and a tendency towards self-representation could have caused inaccuracies in our data. One way to resolve this is to allow researchers to adopt a more active role in identifying improvisations through other data collection means. Extended ethnography could possibly remedy these issues. Third, our findings are based on our interpretation of the collected data, though we shared our findings with the studied organizations. During the analysis we were forced to make occasional judgments about the level and scale of improvisations. The reliability of these findings could have been increased through the use of more raters and better scales during the analysis process.

We see ample opportunities for future research. Developing a more comprehensive model of organizational change and ISE is currently in progress. We also need to extend the current model by showing in detail, the mechanisms which drive incremental changes (improvisations in Q2) into punctuated changes that transform socio-technical systems (Q1 / Q3). Second, we need more detailed analysis of antecedent conditions that affect ISE process at different stages. Though the current model identifies traces of evolutionary events and shows how systems are influenced by them, further research is needed to account for their dynamics over time.

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