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# PREDICTING ORGANIZATIONAL TRANSFORMATION IN ERP ADOPTION: USING A MULTI-LEVEL MODEL TO RECONCILE VARIANCE AND PROCESS THEORIES

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## Introduction

Throughout the growth of Information Systems as a science, a large body of research has attempted to develop predictive theories that explain how people, organizations and society interact with computerized information technologies. While a number of useful predictive theories now exist, a great deal of what goes on when people use computers remains unexplained. In recent years, several theories have emerged that attempt to identify the underlying structures that are the basis of human/computer interactions. These “structuration” theories explain that the reason why human/computer interaction is unpredictable is because individuals and groups are able to uniquely interpret how an information technology is used.

From industry’s perspective, there appears to be little concern about the scientific community’s inability to develop a comprehensive body of predictive theory. The adoption of information technologies continue to generally be given strategic priority, and usually, some improvements in operational efficiency or quality are realized. An extreme case of industry’s insistence that information technologies can predictably transform an organization is the wide-spread implementation of Enterprise Resource Planning systems with their embedded “best practice” processes.

This research attempts to reconcile these two perspectives. We propose that there are both predictive and interpretive components of human/computer interaction, and that by decomposing the interactions into layers, we can isolate and identify the predictive and interpretive elements. We also propose that it is the feedback between the layers that affects the predictability of computer technology use. Lastly, we propose that in the case of ERP, the structure of the system is very rigid and minimizes interpretive processes and feedback, thereby allowing the predictive attributes to drive the interaction. Our research model will be based on Arrow’s (2000) three-layer model of complex groups. At each layer we depict combinations of attributes as regions on a three-dimensional map. We then use the map to explain how the rigid structures embedded in ERP software exert transformational pressure on the organization at each layer. The model will be tested by examining the implementation of PeopleSoft financial software at four campuses within the California State University system.

## Abbreviated Literature Review

This research is grounded in five broad theoretical areas; socio-technical systems, adoption/diffusion of innovation, group dynamics, organizational transformation, and structuration.

Rogers’ *Generalization 10-1* states “Both the innovation and the organization usually change in the innovation process in organizations”. The idea that the organization is transformed by the adoption of the innovation is an important theory in this research.

Mumford (1963) states that technology does not exist independent of the culture that exploits it. Socio-technical Systems (STS) theory generally recognizes the interdependence of technology and human perception and interaction in modern work systems (Gerwin and Kolodny 1992). Rogers (1995) defines an organization as “a stable system of individuals who work together to achieve common goals...”. Arrow et al (2000) define a group as “...a set of patterned relations among members, tasks and tools”. This definition is interesting because it includes tools as part of the definition of what a group is. From these socio-technical perspectives, a software system does not affect the organization, but is rather part of the organization. This definition implies that adopting a new software system concomitantly changes the organization.

One of the key benefits touted by the proponents of ERP is that these systems instantiate hundreds of industry “best practice” processes gleaned from the vendor’s prior implementations (Davenport 1998); (Markus and Tanis 2000). It is presumed that by the mere adoption of the software, that the best practice processes will predictably improve operational efficiency. While all of the promised benefits frequently fail to materialize, more often than not, some improvements are realized. This implies a level of predictability of outcomes far greater than structuration theory would expect.

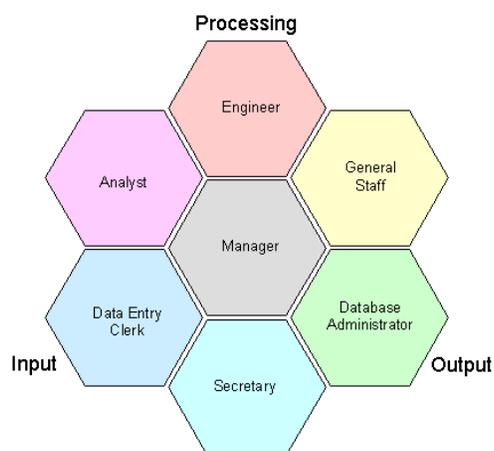
Arrow et al (2000) describe groups as “complex systems”, and define complex as meaning “neither too rigidly ordered nor highly disordered”. They further propose that this complexity can be represented using a multi-layer model. At the bottom layer of this model are the tasks, actions, tools & motives of individual actors, referred to “local dynamics”. At the second layer, referred to as the “global dynamics” layer, are the group actions and behavior that are the result of the individual behaviors, but cannot be adequately described as a simple average or sum of the parts. Examples of these group structures include culture, status and shared knowledge. At the third level are the environmental conditions & factors that affect the operation of processes in the local and global layers. These environmental factors are referred to as “contextual dynamics”. In general, the processes at the lower levels are more orderly (stable & predictable) and those of the group and context layer are correspondingly more chaotic (unstable & random).

Arrow et al (2000) identify a large body of research that use the functionality of computers as a metaphor to describe how groups process information. This is a natural comparison to make since the computer is in fact a construct designed to replicate basic human cognitive processes. Wenger (1987) and Wenger et al (1991) identify encoding, storing & retrieving information relating to computer memory functions. The five basic data processing activities: collection, storage, generation, processing & transportation can easily be applied to individuals as well as to groups. It is these basis information processes that dominate individual tasks within the group, and that are therefore the source of local dynamic structures within an organization.

## Research Model

Each individual in a group has a “portfolio” of assignments and tasks. In the workplace, we can recognize certain job portfolios and identify them with names such as “manager”, “secretary”, “clerk”, “accountant”, “engineer”, etc. Even though the specific assignments vary from person to person and from organization to organization, we can readily classify most jobs by some kind of generally-accepted title. We suggest that within these named job classifications, that the information-processing requirements of individuals are similar. Therefore, if a person’s particular job portfolio has a similar information-processing requirement as someone within a certain job-classification, it would not be inaccurate to describe their job as such, notwithstanding their official title. We suggest that the different task “mixes” that define a job, can be depicted in a three-dimensional map where proximity relates to similarity (Figure 1). Transformation within this layer will be measured by changes to individual job portfolios resulting in movement away from one job classification towards another.

Within the firm, groups of individuals with related duties and handling similar data are often organized into specialized “departments”. Common names given to these “functional organizations” include “sales”, “accounting”, “engineering”, “R & D”, “manufacturing”, “shipping & receiving”. We suggest that groups within a functional category have similar information-processing responsibilities and social norms, and will therefore use similar types of systems. This notion of *isomorphism* (DiMaggio and Powell 1983) is amply supported by empirical research in the field of institutional theory (Fliigstein 1985; Glynn et al. 2000; Hannan and Freeman 1984; Tolbert and Zucker 1983). We therefore propose that if a group’s general responsibility uses similar data and information-systems as a group that can be identified within a functional category, that it would not be inaccurate to describe the group similarly (Figure 2). We suggest that the different “mixes” of responsibility and tools that define a functional organization can be depicted in a three-dimensional map where proximity relates to similarity. Transformation within this layer will be measured by changes to the group’s functional responsibilities that result in movement away from one functional classification towards another.



**Figure 1. Job Portfolios at the Local Dynamics Layer**

## Research Propositions

In his insightful essay on the allocation of tasks in human-machine systems, Jordan (1979) states that people and machines are good at different things. Machines excel in repetitive tasks; people in dealing with contingencies. In this respect, they are not replacements for each other, but rather are “complements”. Gerwin and Kolodny (1992) elaborate on this notion by suggesting that “better social system solutions” result from intentionally placing users and machines in complementary roles. Complementary processes arise as a result of plausible divisions of labor between the tool and the user, and are also found in information processing task sequences. In computerized systems, the software will generally perform the structured, repetitive functions, and the user will perform those tasks requiring the exercise of judgment. An example of a complementary task is a situation where a computer system displays a number of choices, and the user selects one of them. The system’s role is to record and recall the available choices and display them along with some kind of label or explanation, and the user’s role is to decide which choice is appropriate for the situation and indicate through an interface which choice was made. When a technology innovation is adopted that creates or imposes different roles than a previously used technology, then users will “react” to the innovation through the adoption of new complementary roles, thus triggering a transformation. While there is no absolute order for complementary tasks, once the nature of a process is known, and the roles that the software and user play in that process, then the complementary task structures can be ascertained. Since these tasks occur at the individual level, then we anticipate that this phenomenon will most often occur at the local dynamics layer. This gives rise to our first research proposition:

***P1. At the local dynamics level, the structure of the technology causes the organization to adopt a complementary, but different process structure (reaction).***

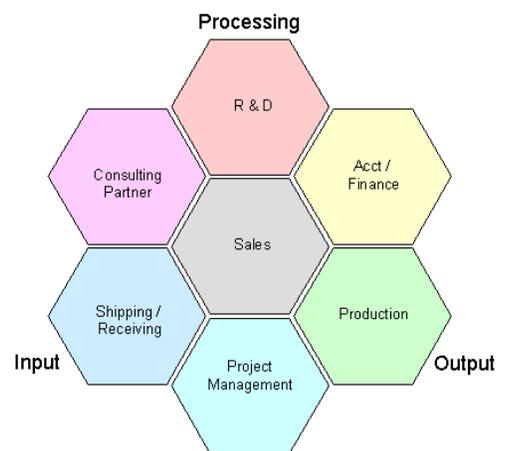
The global variables or “attributes” that define an organization are varied, numerous, and interact uniquely for any given organization. This unpredictability is often referred to as “chaotic”, meaning without a repeating pattern or “randomness” as displayed by deterministic systems (Tsonis 1992). Chaos theory, often referred to “Dynamical Systems Theory” identifies within chaos fixed points around which chaos “orbits”. These fixed points are referred to as “attractors”, “strange attractors”, or “chaotic attractors (Abraham et al. 1990). Arrow (1997) describes a “robust equilibrium” model of group structure that settles into a stable state. The process of stabilization is referred to as “moving towards a single attractor”. Arrow et al (2000) suggest that movement towards a single attractor is descriptive of group structure at the global dynamics layer.

Global dynamic structures refer to group attitudes, culture, rules, norms, practices and informal processes for interaction. Giddens (1984) and Orlikowski (1992) summarize the various global dynamic structures as “meaning”, “power”, and “norms”. It is the chaotic nature of these structures which have informed much of structuration theory & related research. We suggest that standardized accreditation & degree programs, generally-accepted business practices, labor and government regulations, widely-held beliefs about traditional job scope and commonly-accepted definitions of what a “functional organization” is supposed to do, all constrain chaotic group behavior. These norms create behavioral centers around which group behaviors, attitudes, tasks, processes and other structures will stabilize.

Attempts have been made to represent some of the attributes of successful organizations into information system processes. In ERP systems, these structures are sometimes referred to as “best practices”. When designed into a technology, they contribute to what DeSanctis and Poole (1994) refer to as the “spirit” of the technology. We believe that when these structures are strongly evident in the “spirit” of a technology, and when the use of the technology is highly constrained (inflexible) and pervasive, then the set of structures act as single attractor, and the emergent organization structure will move toward a similar point. This gives rise to our second research proposition:

***P2. At the global dynamics level, the structure of the technology causes the organization to move toward a similar structure (mimic).***

These propositions can be summarized in the hypothesis model shown in Figure 3.



**Figure 2. Group Functions at the Global Dynamics Layer**

## Research Methodology

In our research model, the social structure of the ERP software is hypothesized to drive the transformation of the organization. This study will focus on the implementation of the accounts payable process of the PeopleSoft system. This process was selected for several reasons:

- Similar versions of the PeopleSoft accounting software were implemented simultaneously at ten California State University campuses. This implementation was completed approximately twenty months ago. This is a sufficient length of time that transformational effects will have occurred, but short enough that more recent technology adoptions would have either not yet been completed or have had time to have a pronounced effect.
- The flow of accounts payable transactions are fairly constant throughout the year, unlike income transactions that peak at the beginning of each academic session. Therefore the structural components of the software would have a more constant influence.
- Many accounts payable transactions are non-routine, and therefore are prone to use more features of the system and require more human interaction.
- Accounting practices per se tend to be fairly standard, and there is greater likelihood that each of the campuses involved in the research would be using essentially the same software configuration.

The first step will be to create a structural model of the PeopleSoft accounting software. This will be done by examining an installation of the software and creating a process map showing each incoming data component, each user interaction point, each decision point and branches, and each data output.

The next step is to summarize the structure of the PeopleSoft in terms of the attribute matrix and hypothesize the transformational direction that would be implied by its adoption.

We also need to determine what other technologies are in use in the organization and what degree each is used. The structure of any significant product needs to be ascertained and analyzed.

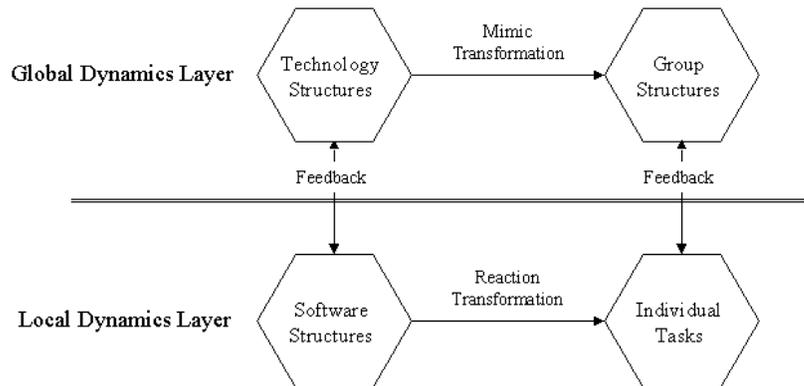
The third step will be to construct a model of the “pre-adoption” organization. This will be accomplished primarily through interviews, examination of the pre-implementation interview notes, pre-implementation readiness assessments, pre-implementation desk instructions, and examining the previous software technology used prior to the PeopleSoft implementation.

The structure of the pre-adoption organization will be summarized using the attribute map.

A structural model of the current organization will then be developed using the results of interview questions and observations of the technology in use. The structure will then be summarized and its location within the attribute matrix mapped.

Before and after views of the organization at each level will be analyzed to determine if the transformations implied by our propositions have in fact occurred.

**Figure 3: Hypothesis Model**



## Pilot Study and Analysis

In order to test our research assumptions, we have examined Wenger’s (1998) case study of an insurance company claims processing organization and applied it to the local dynamics layer of our model. Given that this study was conducted in an attempt to describe communities of practice rather than capture details of social structures embedded in technology and organizations, it still provides sufficient detail to illuminate and lend credence to some of the research propositions.

The job of claims processing described by Wenger consists of entering data from paper insurance claim forms into a computer database application. Forms are submitted both from patients or via their service providers (doctors, etc.). There are many rules that dictate what is covered by an insured’s policy, but most of these rules are not automated in the software, but must be applied by the claim’s processors themselves. From this case we can therefore deduce the following roles of the claims processors:

- data entry
- deciding whether a claim is covered by an insured’s policy
- assigning / calculating benefits (payments)

We can further identify the roles played by the computer system:

- displaying patient / claim information
- displaying decision options
- recording/storing patient & claim information

This gives rise to the following role complements:

<b>Computer System Role</b>	<b>Claims Processor Role</b>
display menus	type in claim information
display menu field options	select appropriate choice
display information	verify information is current/ correct

<b>Claims Processor Role</b>	<b>Computer System Role</b>
enter information	record information
enter information	calculate benefits
enter information	retrieve record / additional information

In each role dyad, each actor assumes a role to which they are most suited. The computer system records, retrieves, calculates & displays information. The claims processors make decisions and apply the business rules to the data. We believe that when an organization adopts a new ERP system, that the processes will require users to adopt new complementary roles based on the capabilities of the new system.

Since the case study does not provide us with a view of the organization before the current system was adopted, we are not able to comment on any possible transformations that might have occurred. We can however, use the current case and apply an imaginary new system, and discuss its potential for causing transformation. The claims processor’s job consists of two primary functions: data entry and decision-making. Claims processors also handle telephone inquiries from claimants, but to simplify this illustration we will ignore its possible effects. There is potential for process improvements in both task areas. If a new system was installed that significantly reduced the data entry workload, such as image scanning or electronic claims submittal, then the bulk of the claims processor’s time would relate to cognitive decision-making. All other things being equal, this would cause a job transformation away from the data-entry function towards the analyst function. On the other hand, if a new system were installed that could automatically apply the benefit rules thereby reducing much of the cognitive load, the job would be primarily typing, and would therefore shift away from data-entry function towards the secretary function. From a practitioner perspective, either transformation has significant implications in terms of skill requirements, compensation, workgroup culture, etc.

## Expected Contribution

We believe that there are both predictive and interpretive components of human/computer interaction, and that is the amount of user “interpretation” that a system allows that affects the predictability of computer technology use. We also believe that in the case of ERP, the structure of the system is very rigid and minimizes interpretive processes and feedback, thereby allowing the predictive attributes to drive the interaction. This research will explore the degree of impact that these rigid structures have on adopting organizations. Within the scope of this global objective, we hope to make the following specific contributions:

- Develop and test of a model that at least in part reconciles two conflicting theories of the adoption of innovations.
- Contribute important ideas about the types of effects different software system attributes have on organizational structure.
- Develop a new way of depicting changes in organizational attributes in a way that is visually intuitive.

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