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GENERATING INSIGHT FOR REENGINEERING

by

Kenneth Ronald Walsh

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A Dissertation Submitted to the Faculty of the
COMMITTEE ON BUSINESS ADMINISTRATION

In Partial Fulfillment of the Requirements
For the Degree of

DOCTOR OF PHILOSOPHY
WITH A MAJOR IN MANGEMENT

In the Graduate College
THE UNIVERSITY OF ARIZONA

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read the dissertation prepared by Kenneth Ronald Walsh
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requirement for the Degree of Doctor of Philosophy with a Major
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ABSTRACT

As organizations face stiff competition and changing environments their structure and systems can become less effective to a point at which they require radical change. It is becoming clear that change is often inevitable. However, radical change is difficult. The popular term “reengineering” is used to describe a process by which organizations undergo the challenging radical process change that is critical to remaining competitive. Although the processes of reengineering appears to have more potential than other change methods that merely tweak a poor system or apply outdated principles, it can often fail.

A critical step in the reengineering process is the design of the “to-be” model, however no research has been done on how this should be achieved. It appears that improving this step can have a dramatic impact on the success of the reengineering effort as a whole. This study developed a method for creating “to-be” models and tested it with an organization undergoing reengineering. The method used the latest computer support including both group support systems and animated simulation. The design of the “to-be” models was framed as a group problem solving process and therefore the focus theory of group productivity was used to guide the design of the process, including selection of computer support tools.

Because so little is known about the process of creating “to-be” models, this study used an exploratory action science approach. What is known about organizational change is that it takes place in a politically charged arena where individuals have strong

vested interests in its outcomes. This environment is difficult to create in the laboratory and therefore the research was conducted using a real organization undergoing reengineering.

Results suggest that the combined use of collaborative technology and process animation gives organization members a better understanding of current processes and problems associated with them and helps to generate significant ideas for process improvement. Because groups viewing a process animation have sometimes been observed to focus on incremental improvement at the expense of radical change, special attention must be given to facilitation methods and idea generation techniques that are designed to elicit radical change ideas.

CHAPTER 1. INTRODUCTION

As organizations face stiff competition and changing environments their structure and systems can become less effective to a point at which they require radical change. It is becoming clear that change is often inevitable. However, radical change is difficult. The popular term “reengineering” is used to describe a process by which organizations undergo the challenging radical process change that is critical to remaining competitive. Although the processes of reengineering appears to have more potential than other change methods that merely tweak a poor system or apply outdated principles, it can often fail.

A critical step in the reengineering process is the design of the “to-be” model, however no research has been done on how this should be achieved. It appears that improving this step can have a dramatic impact on the success of the reengineering effort as a whole. This study developed a method for creating “to-be” models and tested it with an organization undergoing reengineering. The design of the “to-be” models was framed as a group problem solving process and therefore the focus theory of group productivity was used to guide the design of the process, including selection of computer support tools.

Because so little is known about the process of creating “to-be” models, this study used an exploratory approach. What is known about organizational change is that it takes place in a politically charged arena where individuals have strong vested interests in its outcomes. This environment is difficult to create in the laboratory and

therefore the research was conducted using a real organization undergoing reengineering. Because of the exploratory nature of the study and the need for a realistic environment, the action science approach was employed.

1.1 The Need for Fundamental Business Change

Today's competitive environment is changing faster than ever before. Hammer and Champy write, "American corporations must undertake nothing less than a radical reinvention of how they do their work," (1993, p. v). Radical business process change appears to be necessary if organizations are to survive and thrive in such an environment.

The marketplace has changed from one that offers standardized, long-lived, information-poor products to one that offers individualized products that are changed at an ever quickening pace and embody rich expertise and knowledge (Goldman, Nagel, and Preiss 1995). These changes require fundamentally different business processes for their effective support. Past organizational design paradigms relied on economies of scale for mass market products creating large, departmentalized operations that contributed to efficiency and control. Today, this paradigm can entrench an organization in its way of doing business to the point that it is offering efficiently produced products that are no longer valued in the marketplace. The shift is to mass customization where, for example, a pair of jeans can be purchased that are cut to an individual's specific measurements without any added cost over off-the-shelf products.

The ability to effectively offer these higher levels of customer service is enabled by technology in general and to a greater and greater extent by information technology. The problem in applying technology is that it is often used to automate current business practices without realizing its potential to create new ways of working. Companies that use information technologies to make incremental improvements in efficiency will have little power to compete against companies who can offer customers more effective products and services that could not be delivered without the technology.

Many business processes were designed using assumptions that have become outdated and are in need of radical change to regain their former competitiveness. Hammer and Champy (1993) suggest that for organizations to meet the challenges of today's competitive environment, previous organizational design principles centered around the decomposition of tasks into their most basic elements should be abandoned. Better principles are centered around combining closely related tasks to create more integrated, higher quality processes. The previous design principles often still guide managers and further entrench poor business practices.

Although change appears critical, fundamentally changing business processes and employing new design principles is not easy. It requires an understanding of the organizations goals, the competitive environment, the current processes, and the available technology. This understanding is not usually found in any one person in an organization and therefore requires coordination effort between a number of individuals. Further, the political environment of the organization consisting of individuals with often conflicting goals stands in the way of the process.

1.2 The Potential of Business Process Reengineering

Business process reengineering (BPR) is a method for radically changing business that appears have potential for helping organizations face current challenges. BPR seeks the radical redesign of core business processes in light of the current competitive and technological environment and using newly emerging principles of business design. BPR differs from TQM and continuous improvement efforts in that it seeks to fundamentally change the way processes are conducted rather than making adjustments to processes as they stand making BPR a better contender for achieving the results of which businesses are in need.

1.2.1 BPR Defined

“Reengineering,” properly, is “the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed.” (Hammer and Champy 1993, p. 32)

Hammer and Champy’s definition captures the essence of reengineering and is probably the most used today. The critical phrases in this definition are “radical redesign” and “business processes.” The phrase “radical redesign” implies that the current paradigm of doing business should not be held as a constraint in its redesign. The phrase “business processes” indicates the focus needs to be on processes rather than departments.

However, the biggest leaps in improvement are likely to occur when designers take into account the potential of information technology (Marsden and Pingry 1985,

Davenport 1994). Therefore, it is useful to add to Hammer and Champy's definition "in light of available technology."

1.2.2 Alternatives to BPR

This is in contrast to earlier business improvement methods such as total quality management (TQM), which emphasized incremental improvement. Furey (1993) describes the difference between continuous improvement and reengineering in terms of experience curves as shown in Figure 1.1. An improvement along one experience curve from point A to point B represents the incremental improvement of continuous improvement strategies. Reengineering seeks to move the organization to a completely different and improved curve that can be represented as a move from point B to point C.

Figure 1.1 Comparative Experience Curves (adapted from Furey 1993)

Reengineering is also different than automation. Automation seeks to find the best technology to support current business practices. Marsden and Pingry (1985) argue

that optimizing technology for a given business practice will lead to a less optimal system than if both the business practices and the automation are allowed to vary. Reengineering focuses first on improving business practices and second on designing automation. Even focusing on these as two distinct steps would still be suboptimal to varying both simultaneously, as recommended by Marsden and Pingry. However, inefficiency can be mitigated if the participants in the change process are aware of potential automation technology while designing the business practices. Davenport (1994) describes the problem in human terms: the benefits of new technology are often not realized because an organization's information culture is not correspondingly changed. "IT solutions must help employees do their work and support the cost and quality objectives of the company, not be overlaid on a sub-optimal organizational structure and business processes" (Cole, Clark and Nemec 1993, p. 22).

Further, the information culture may be more difficult to change than the information technology, so implementing information technology without consideration of the culture may cause the culture to fight against the technology (Davenport 1994). This has implications for both organizational design and the process of organizational design.

Large investments in automation do not seem to be yielding the returns envisioned. Simply speeding up processes does not address their fundamental deficiencies (Hammer 1990). Hammer describes how 400 accounting clerks at Ford Motor Company are needed to do the work that five can do at Mazda, where the job had previously taken 500 clerks. Even after Ford management implemented a new

information system which gave a 20% increase in productivity, the system could in no way compete with Mazda without substantially reengineering the process, including interacting processes outside the accounting department.

1.2.3 The Unique Potential of BPR

It appears that BPR offers a unique potential as a tool for improving an organizations competitiveness. Hammer and Champy (1993) argue the case that incremental change is not enough for many organizations and more radical approaches are necessary for them to survive. Davenport (1994) argues that BPR is the only way to take advantage of changes in technology.

1.3 *Limitations of BPR*

Unfortunately, many companies, possibly 50% to 70%, fail to achieve the results that they desire (Hammer and Champy 1993). Little systematic research has been conducted that can determine where in the reengineering process is the point of failure. Some may argue that it appears that the failure is in implementation. This may be an obvious place to begin to look because it is where the symptom of failure occurs. However the cause of implementation failure may well be upstream in the reengineering process. In fact no implementation can occur until something to be implemented has been designed. Another potential failure point of reengineering processes is at the beginning in the creation of the strategy that led to the reengineering effort. However,

the failures that Hammer and Champy have noted are failures to implement the change as intended, a failure that occurs before the value of the strategy has even been tested.

The design of “to-be” business process lies at the heart of the reengineering effort and is a potential weak link in the process. Little has been documented about this process and it is therefore premature to label it as the culprit, but it appears to be an appropriate place to begin looking.

Some may contend that implementation is a more important or more difficult part of reengineering, but no process can be implemented before somebody has the inspiration and knowledge to design it. Further, the process of design is in itself the first step of implementation because, when done well, it educates the people who will be effected by the changes and begins to coalesce support for the those changes.

An important predecessor to most “to-be” design efforts is the documentation of the “as-is” system. Dean (1995) has reported on an effective way for modeling the “as-is” system in order to provide this documentation. What is not known, however, is how that information should be used in the creation of the “to-be” design.

1.4 The Research Question and Its Significance

Central to the reengineering process is the design of the “to-be” business model that the organization will strive to implement. This model may emerge as either a leading candidate from a number of proposed models or possibly a synthesis of many. It may or may not contain aspects of the current system, however, it is likely to be subject to some constraints of the organization’s history.

Possibly the most important and most difficult part of reengineering once a decision to reengineer has been made is the design of the “to-be” model yet little research has focused on this critical step. A number of authors have investigated important success factors for reengineering such as the important factor “management support”. Clearly if a reengineering effort does not have management support, an organization is unlikely to undertake a full fledged reengineering effort and even if they do, they are unlikely to muster the resources to complete it. But given that management is committed to the effort, surprisingly little research is available to guide the redesign process itself.

No research to date has fully addressed the processes of creating “to-be” models for reengineering. In most studies a research team, which may or may not include expert process consultants, emerges from arduous deliberation with a novel idea but little is understood about how this process works. Some studies recommend looking at the processes of other successful organizations, however, the most successful organizations that they cite as examples were not imitators. Just imitating competitors is not likely to be enough. Also, the best reengineering efforts often exploit idiosyncratic opportunities of the organization that may not transfer easily to other organizations.

Therefore it is critical to understand how “to-be” organizational models can be created and how the process of their creation can be improved. The complex nature of the task and the reliance on a group of decision makers makes it clear that process and task support will be necessary for best results, but the specific type of support and how it is applied is not clear and therefore needs exploration.

Although, Hammer and Champy suggest that current business models should be obliterated and “to-be” models should be created from a clean slate. They describe eight lessons of process redesign including, “You don’t need to know much about the current process” (p. 147). Many researchers disagree, claiming that the current system provides many of the requirements for the new system.

Previous work has developed methodologies for business engineering (BE) (Daniels 1991, Meel 1993). Other research has demonstrated design principles for reengineering (Hammer 1990, Davenport 1993). However, none of these has developed a method for the design of the “to-be” model.

Reengineering efforts are group efforts, requiring cross-functional teams working over a period of time. GSS have been developed and shown to be effective for a variety of collaborative tasks. This study used a GSS to help a reengineering team create a “to-be” business model. Although GSS have been studied extensively as providing support for collaborative tasks, less attention has been paid to team projects such as reengineering that require support over time (Morrison, Morrison, and Vogel 1992). This study attempted to use GSS technology within a collaborative environment that supports the team both during meetings and between meetings.

GSS can provide both process support and task support. However, in complex organizational design activities, the task support of GSS is likely to benefit from augmentation with specific reengineering task support. Understanding and analysis of complex business models can be improved by computer based modeling tools. This

study used animated simulation to provide both rigorous computer experimentation of alternative models and vivid animation to help groups understand processes.

Dean (1995) has begun working with a particular GSS that supports business modeling. His work has focused on the Integrated Computer-Aided Manufacturing Definition Language 0 (IDEF0) method of activity modeling. Dean notes that the strengths of the IDEF0 method include its ability to “purposely abstract away from organizational structure, actors, sequence, and geographical location of work” and also its use of hierarchical decomposition to manage complexity. These benefits have helped large groups develop “as-is” models of complex business processes. However, these strengths can mask some of the problems in a process and make it more difficult to develop improved solutions. Animated simulation is one way to display a system, including sequence, holistically while using enough abstraction to keep users from being overwhelmed by complexity.

This research attempts to use models of current business processes as catalysts for generating insight into improved processes. Though the goal of reengineering is radical improvement, ideas leading to it may come incrementally by building on other ideas until a radical new design is developed. One difficulty of this approach is the difficulty of development of process models that can be readily understood and recognized by the people analyzing them. Another difficulty is managing the generation of improvement ideas process in a way that allows groups to devote their efforts to thinking of business improvements, rather than organizing meetings. We have attempted

to use two technologies, group support systems (GSS) and animated simulation, in concert to alleviate these problems.

- ◆ *How can collaborative computing technology and process animation be used to help groups create “to-be” business models?*

1.5 The Research Approach

This research approach views organizations as social systems where decision making can be characterized as employing satisfying rather than optimizing principles that are enacted within complex political systems when individual goals are not in complete agreement. Additionally, this approach is normative in that it seeks to change the organization under study for the “better.” It applies the latest available technologies to help organizational members change their work patterns in a way that will improve their processes. An action science approach as proposed by Argyris, Putnam, and Smith (1985) is therefore implemented, within the framework of systems development (Nunamaker 1992). This approach differs from a case study approach as defined by Yin (1994) in that it is interventionist, although it draws upon similar methods of observation and data collection.

Bostrom and Anson (1992) noted that GSS technologies require further decisions on when and how to use the tools for them to be effective. Similar choices of when and how to use the available technologies were an important part of this study as well. In many cases, implementation decisions were modified in light of their emerging effects on the process.

Though this research was focused on the use of GSS and animated simulation to develop “to-be” models, just one step in the reengineering life-cycle, it was conducted in a real organization with real reengineering needs, so the study included a significant portion of the reengineering life-cycle. The use of a real organization undergoing full scale reengineering is critical to the external validity of the study and helped identify issues which can be further studied in the laboratory.

In order to preserve the external validity of study, a target organization that had recently completed a strategic planning exercise was selected. That exercise suggested that dramatic organizational change was needed if the company was to remain competitive and meet the expectations of its stakeholders. The organization is a market leading software development company that produces and sells GSS software in the burgeoning groupware market.

Like many companies today, it was not designed to operate as it does today, but rather has grown incrementally. Many of the systems in use were effective in the context of a smaller organization. However, as the company grew and processes were fragmented across departments, those systems became inefficient. Competitive pressure from established software corporations that recognize the value of their market and the changing technological needs of their customers have become significant threats to the organization and hastened the need for improvement.

This study began the reengineering process where the earlier strategic planning work had left off. It analyzed the current systems and developed potential “to-be” models, leading to conclusions and recommendations to management.

1.6 Organization of Dissertation

Chapter 2, “Significant Prior Research,” gives an overview of previous related work and its limitations. Chapter 3, “Theoretical Foundations,” describes the theoretical basis for the approach taken and its anticipated impact on the study. Chapter 4, “Research Approach,” describes the methodology and procedures used in the study. Chapter 5, “Target Organization,” describes the organization that was studied. Chapter 6, “Revised Theoretical Model,” describes the findings of the study and how the theoretical models described in Chapter 3 should be modified in their light. Chapter 7, “Discussion,” summarizes the contributions of the study and discusses potential future research.

Although researchers may be interested in the entire dissertation, executives can read sections 5.1, 5.2, 5.8, 5.9, and Chapter 7 for an overview of the organizational problems, reengineering process and recommendations. A reengineering practitioner may read Chapters 5 and 7 and Appendixes A through C for a detailed description of the reengineering processes and the implications for practice.

1.7 Chapter Summary

Reengineering is the radical redesign of business processes. The difficulty lies in understanding how to develop improvement ideas that can be synthesized into a vision and a model of how an organization should operate. This research used collaboration technologies and process animation in combination to improve the process of creating “to-be” models, a critical step in any reengineering effort. The study used both systems

development and action science methodologies to study the efficacy of the approach and tools in a complex real-world environment. This dissertation presents in detail the justification, methodology and findings of the study.

CHAPTER 2 SIGNIFICANT PRIOR RESEARCH

Section 2.1 summarizes prior research on reengineering. Reengineering has similarities to other complex organizational problem solving domains and can benefit from the adaptation of tools used in those domains. Two promising technologies are GSS and animated simulation. Section 2.2 describes the research on GSS and Section 2.3 describes the application of GSS in the organizational design context. Previous work in GSS suggests that a lack of support for the understanding of complex dynamic processes still exists in the GSS tools, therefore, to augment the task support of GSS tools, we will consider animated simulation which has important strengths in modeling complex processes. Section 2.4 describes previous research on animation and simulation and Section 2.5 describes its application in the organizational design context.

Though these technologies appear promising, little is known about their applicability in helping design “to-be” models as part of a reengineering project. This study was therefore exploratory in nature and was used to discover how the technologies could be applied. Section 2.6 summarizes the chapter and limitation of previous research that were addressed in this study.

2.1 Reengineering Research

Sometimes it happens on the drive home after a tough day. Or it may occur in the middle of a business meeting. But more than likely, it builds up in your gut—like an ulcer. Regardless of how, sooner or later managers come to a disturbing and painful recognition. The business systems and organizations that they helped build over the years may be

fundamentally out of touch with the realities of the marketplace. (Cross, Feather and Lynch 1994)

The recognition of being fundamentally out of touch has drastic implications for what business needs to do. Incremental improvement and automation are likely to have little effect in this situation. Cross, Feather and Lynch (1994) argue that corporations are at the brink of a renaissance.

Early reengineering studies suggested that knowledge of the current business model not only was not needed but also could be limiting. Hammer (1990) argued for its obliteration. Later work showed that since the current system represents the only documentation of constraints on the system, and in some cases the constraints may need to be changed, documentation of those constraints is important if they are to be overcome. In a 1993 interview, Hammer made it clear that “it’s critical to develop a process map of the organization” (Randall 1993). Cross, Feather and Lynch (1994) have shown the importance of developing baseline perspectives, or an understanding of where the organization stands both internally and externally. This helps create a shared vision for the project and helps make decisions on where to focus. Martin (1993) argued for reverse engineering the current system to understand how it really works. Without reverse engineering, organizations may rely on the espoused strategies of managers that can mask the real problems.

These perspectives make it clear that the creation of an “as-is” model is a necessary step in reengineering. They recognize that the creation of the “as-is” model has important consequences for the ensuing reengineering effort, but they do not

describe a process whereby the “as-is” model is used in the subsequent step of creating the “to-be” model.

Reengineering research has generally focused on the areas of critical success factors or common errors for reengineering projects and on taxonomies of the design strategies used.

2.1.1 Characteristics of Reengineered Processes

Hammer and Champy (1993) have offered a list of characteristics of reengineered processes as shown in Figure 2.2. Item one in Figure 2.2 highlights the paradigm shift that needs to occur in reengineering. Not only do organizations change processes dramatically in a reengineering effort, but the principles they use to design the processes change. Combining several jobs into one is probably the opposite recommendation to the one that Adam Smith would have made, but contemporary demands for flexibility and quality make job combination and Hammer and Champy’s other recommendations useful strategies. Indeed the principles of Fredrick Taylor (1915) need to be reconsidered, drastically, in light of changes in the technological and competitive environments that organization now face. Hammer and Champy also suggest that these recommendations transcend industry types. A fundamental rethinking of how work is accomplished is needed in this era when land, labor and capital become secondary to knowledge (Drucker 1992).

-
1. Several jobs are combined into one
 2. Workers make decisions
 3. The steps in the process are performed in a natural order
 4. Processes have multiple versions
 5. Work is performed where it makes the most sense
 6. Checks and controls are reduced
 7. Reconciliation is minimized
 8. A case manager provides a single point of contact
 9. Hybrid centralized/decentralized operations are prevalent
-

Figure 2.2 Common Characteristics of Reengineered Processes
(excerpted from Hammer and Champy 1993, p. 50-64)

Although the characteristics that appear to be common in many reengineering processes as presented by Hammer and Champy (1993) are informative in describing how the results of reengineering differ from other organizational design paradigms, they offer little help in process of designing a new organization. It is not likely that any list of characteristics is complete because it is not these particular characteristics that define reengineering, but rather the concept of process change for radical improvement. Further, the characteristics give little insight into how the process of “to-be” design should be conducted.

Huber and McDaniel (1986) argued for the need for a paradigm shift in the principles of organizational design that can explain the contradictions between Hammer and Champy (1993) and Taylor (1915). Huber and McDaniel also described three paradigms of organization design that have dominated organizational thinking in various eras and have become less applicable in recent years. It should be noted that these paradigms are not mutually exclusive and can be seen coexisting in modern

organizations. However, the emphasis has shifted dramatically. The first paradigm is paternalistic/political and focuses on maximizing the leader's political power by allocating resources based upon subordinates' loyalty to the leader. Competitive pressures helped give rise to the accountability/authority paradigm. This second paradigm takes a rationalized approach to management in which resources are allocated to those seen as having the highest likelihood of completing the task. It is within this paradigm that the work of Fayol (1949) and Weber (1947) fits. The next paradigm to emerge is the workflow paradigm that emphasizes the creation of administrative structures that correspond to steps in the production process.

Huber and McDaniel (1986) argued for the need for yet another paradigm shift to what they call the decision-making paradigm of organizational design. As line production jobs decline as a percentage of the economy, more and more jobs are focused on individuals making decisions on behalf of the organization and it is the quality of these decisions that leads to effective organizations. In terms of Hammer and Champy's (1993) emphasis on combining jobs rather than fragmenting jobs, this can be seen as a change from the workflow paradigm to a decision-making paradigm in that the completion of an individual task is de-emphasized in order to put more of the process in the control of a smaller number of decision makers. The quality of decisions can be improved by giving decision makers a broader understanding of the process.

Goldman, Nagel and Preiss (1995) echo the need for flexibility. They call it "agility" and argue that it is today's most important source of competitive advantage, surpassing economies of scale.

Galbraith and Lawler (1993) are largely in agreement with Hammer and Champy (1993) and Goldman, Nagel and Preiss (1995) on the characteristics organizations need to be effective in the future. However, they add the importance of creating organizations that can continue to change. The environment is continuing to change quickly and organizations need to conduct first-order change, redesigned process, but also second-order change, understanding and having the ability to adapt to future changes.

Davenport (1993) also argues for the need for dramatic change, but he has a strong focus on the enabling properties of information technology (IT). He agrees with others that IT should not be used to automate existing processes, but acknowledges that understanding how IT can change the way people work is necessary for developing the best processes. This point of view is similar to that of Marsden and Pingry (1985) who suggested that organizational systems and IT need to be varied simultaneously in order to find the optimal coupling.

Hall, Rosenthal and Wade (1993) describe the need for reengineering to seek dramatic change as the need for “expanding the dimensions of reengineering” (p. 120). Their study of 20 organizations undergoing change showed that the lasting bottom-line results came from efforts that spanned multiple business units to cover the full breadth of processes and made dramatic changes to the fundamental processes.

This research suggests that the correct way to design processes today is different than is used to be. The characteristics in Figure 2.2 are examples of this paradigm shift. But applying these example characteristics and potentially many others that are consistent with them is difficult and many organizations fail. No process exists for

helping a group manage the complexity of the task and organizations are left to prolonged unstructured meetings that may or may not result in design options.

2.1.2 Reengineering Lessons

Hammer and Champy (1993) listed common errors that cause reengineering efforts to fail, as shown in Figure 2.3.

-
1. Try to fix a process instead of changing it
 2. Don't focus on a business process
 3. Ignore everything except process redesign
 4. Neglect people's values and beliefs
 5. Be willing to settle for minor results
 6. Quit too early
 7. Place prior constraints on the definition of the problem and the scope of the reengineering effort
 8. Allow existing corporate cultures and management attitudes to prevent reengineering from getting started
 9. Try to make reengineering happen from the bottom up
 10. Assign someone who doesn't understand reengineering to lead the effort
 11. Skimp on the resources devoted to reengineering
 12. Bury reengineering in the middle of the corporate agenda
 13. Attempt to reengineer when the CEO is two years from retirement
 14. Fail to distinguish reengineering from other business improvement programs
 15. Concentrate exclusively on design
 16. Try to make reengineering happen without making anybody unhappy
 17. Pull back when people resist making reengineering's changes
 18. Drag the effort out
-

Figure 2.3 Common Reengineering Errors (excerpted from Hammer and Champy 1993, p. 200-213)

Little work has been done on how to find new ideas for process redesign. Cross, Feather and Lynch (1994) suggest three ways to do so: review the work of others, look at competitors, and collect ideas from the workers. On reviewing the work of others they

comment, “But such research is usually limited and highly focused. Because the best reengineering ideas come from the creative energies of a team motivated to produce the benchmark, not to copy others...”

Efforts to achieve radical improvement will introduce instability into any organizational system. We simply cannot plan well enough to get everything right immediately. Continuous improvement must be fostered by the design. (Cross, Feather and Lynch 1994 p. 179)

Work processes need to be designed with measurement built in. If quality measures are integrated with the work, they will add minimal cost to the processes and workers are more likely to continue to track the measures. Of course the measures are of little use without a review and improvement process in as well.

Stow (1993) argues that it is critical to define objectives of the reengineering effort, both to set the goal of the project and to guide the endeavor.

2.1.3 Organizational Change

Reengineering is only one form of organizational change. Many have been tried. They all have in common a task that is never easy and often fails. Organizational history often traps organizations into denying that their products are no longer desired and their operations no longer effective. Because, it is often what an organization does right that gets it in trouble, it is critical for organizations to approach change initiatives without blaming the participants (Martin 1993).

Duck (1993) describes the difficulty in managing change that stems from the need “to manage the dynamic, not the pieces” (p. 109). Organizations are likely to find

that many parts of the organization are changing simultaneously, so a key challenge becomes ensuring the changes are complementary.

Learning organizations are those that can adapt and improve, often incrementally. Although reengineering favors dramatic change, a reengineered organization can benefit from design considerations that can help it further improve. “If learning organizations are not possible, we must still act as if they were” (Martin 1993, p. 92).

2.1.4 The Role of Group Work

Group work is playing an increasingly important part in organizational life. Organizations are attempting to become flatter and push decision making to lower levels in the hierarchy. In many cases, teams are being asked to make decisions or at least recommendations.

Reengineering and other forms of organizational improvement have team work in common when cross-functional teams are assembled to help improve processes from a process wide point of view rather than a departmental view.

But group work is difficult. Meetings are difficult to conduct and often do not meet expectations. However, recent developments in computers, networking and software have made it possible to use computers to facilitate group communications, making team work more effective. This technology is often referred to as group support systems. Not only does it help team projects such as reengineering, it also can enable the newly reorganized business processes, facilitating flatter organizations, encouraging

participative management and a number of other modern management techniques. Weatherall and Nunamaker (1996) describe a number of applications of the technology.

2.2 Group Support Systems Research

GSS are networked computer systems and software that change the way groups collaborate (Dennis et al. 1988, Nunamaker, Dennis, Valacich, Vogel and George 1991). GSS software provides a collection of general purpose collaboration tools that help groups generate ideas, discuss issues, organize information, write reports and prioritize items more effectively than the manual techniques often used by groups. Improvements in productivity are so great that they transform the way group work is designed by freeing groups from the typical constraints of group size, participant apprehension and a synchronous meeting time. The general purpose nature of the tools allows them to be adapted to a variety of group activities or problem solving situations. GSS are beginning to be applied to reengineering where the challenging, large-scale, political issues present a new opportunity for their application. The roots of GSS research lie in work done in the 1970s on computer messaging and decision support systems (DSS) (Dennis and Gallupe 1993) which combined modeling and processes of decision making with group communication.

Adoption of the technology is generally not sufficient by itself to allow groups to realize significant productivity improvements (Bostrom, Anson and Clawson 1993). The systems are generally used with expert facilitation and planned structured processes, without which the tools can actually reduce productivity. While, the tools offer

considerable process support, choices of when and how to invoke this support are still critical to successful usage (Bostrom and Anson 1992). Facilitation support is needed before meetings to design plans and agendas, during meetings to focus the group's activities or change the agenda, and after meetings to disseminate information and plan subsequent steps (Bostrom, Anson, and Clawson 1993). As the tools become more widely used, the planning and facilitation of their use will probably be done to a greater extent by group participants and leaders, but expert GSS facilitators continue to be heavily used today.

GSS can be located within a single meeting room or distributed throughout the world. These systems generally require reliable high band-width communication links so that delays do not interfere with participant's communication. The systems save electronic communication as it occurs and provide a shared record of the process and decisions. People engaged in collaborative activities on a system can work at the same time or at different times. However, all modes of GSS usage require a process leader and synchronizing technology to keep groups focused and working toward a goal. In some groups, the process leader may not be the same person throughout a process, and the process leader often is not a member of the group. In a single meeting room, the synchronizing technology is a public screen on which the process leader can ask the group to focus, synchronizing group members' behavior and clarifying their charge. In same-time distributed environments, the synchronizing technology is often an audio or video channel, at a minimum between the leader and the participants, but possibly intra-participant as well. In different-time environments, the synchronizing technology is

often published procedures and electronic mail. Abel et al. (1992) shows how to incorporate point-to-point teleconferencing to support group work.

It should be noted that this technology is often referred to by a variety of names. The term group decision support system (GDSS) was frequently used in earlier research and is still used today. Critics of the term note that the systems are used for more than just decision making. They are heavily used for communication. Dennis et al. (1988) proposed the term electronic meeting system (EMS) and defined it as encompassing both face-to-face and distributed forms of the technology. The term can still evoke the connotation of the face to face meeting, however. Furthermore, the systems are being used for more than meetings as their features are expanded to support various projects. Another commonly used term is computer-supported cooperative-work (CSCW). This term is generally used by researchers who focus more on communication than on problem solving. The difference between the areas of research emphasis are considerably blurred as each incorporates findings and features of the other. The term group support system (GSS) will be used throughout this dissertation as it seems to be a widely accepted general term for this type of technology and is used extensively in recent literature. When particular reference to either the GDSS or CSCW streams of research is needed, those designation will be used. See Jessup and Valacich (1993) for a brief history of the research areas and a list of common terms used in the field. See Wagner, Wyne and Mennecke (1993) for a list of some of the prominent research facilities conducting research in this area.

2.2.1 The Tools of GSS

The networked computer systems of a GSS run specialized software that provide users with a collection of collaborative tools. An example of a set of tools and the functions they provide is shown in Table 2.1, adapted from Nunamaker, Dennis, Valacich, Vogel and George (1991). These tools are found in the GSS package, GroupSystems, developed at the University of Arizona. Valacich, Dennis, and Nunamaker (1991) give an overview of the GroupSystems concept. GroupSystems runs on networked IBM-PC compatible computers. Other universities have also developed tool sets. One of these is the SAMM system at the University of Minnesota which is designed to run under the AIX (UNIX) operating system (Dickson, Poole, and DeSanctis 1992).

From Table 2.1 it is apparent that some tools can be used for more than one function. For instance, a number of tools are listed as being useful for idea generation as well as idea organization. Newer GSS packages such as GroupSystems for Windows contain tools with greater overlap in functionality and allow a process leader to select from a number of features to customize each tool. For example, the new version of Vote allows users to generate ideas as well as prioritize items (GroupSystems 1993).

Tool	Idea Generation	Idea Organization	Prioritization	Policy Development
Electronic Brainstorming	P ¹	S		
Electronic Discussion	P	S	S	
Topic Commenter	P			
Group Outliner	P	S		
Idea Organizer	S	P		
Issue Analyzer		P		
Group Writer	S	P		
Vote Selection			P	
Alternative Evaluator			P	
Group Questionnaire			P	
Group Matrix			P	
Stakeholder Identification				P
Policy Formation				P

¹P indicates primary function, S indicates secondary function

Table 2.1 Example GSS Tools and Their Usage (adapted from Nunamaker, Dennis, Valacich, Vogel and George 1991)

Each of the tools can be sequenced in an order specified by the process leader to address a variety of group needs. Data generated in one tool can be transferred to the next tool for further analysis. A tool sequence generated before a meeting is called an agenda and is important to a meeting's success, even though agenda changes during a meeting are common. A typical sequence of meeting steps in a problem solving domain is shown in Figure 2.4, adapted from Nunamaker, Dennis, Valacich, Vogel and George (1991). This figure is a generic simplification of a sequence. Real meetings vary considerably in the sequence they employ. Some meetings may use a single tool but

vary the options as the meeting moves through a number of phases.

Other meetings may use a number of instances of the same tool.

2.2.2 The Features of GSS

Features common to most GSS tools—anonymity, parallel processing and group memory—help groups become significantly more

productive than unsupported groups. The tools can free groups from typical constraints of group work such as group size, participant apprehension and synchronous meeting time. Additionally, groups experience a synergy that produces process gains beyond the benefits that would be expected by removing the constraints.

Anonymity mitigates evaluation apprehension by freeing participants to express ideas that they perceive as not in conformance with group norms, but are considered relevant by the individual (Nunamaker et al. 1993). They need not fear that off-the-wall ideas may make them look bad in front of their peers and it is often such ideas that help a group to novel solutions. Laboratory experiments have shown that anonymous groups generated more ideas than identified groups. This research has also shown that when a confederate entering critical comments participates, the number of ideas is increased

**Figure 2.4 One Sequence of Meeting Steps
(adapted from Nunamaker, Dennis,
Valacich, Vogel and George 1991)**

further. However, these groups show lower levels of satisfaction than identified groups with a supportive confederate (Connolly, Jessup and Valacich 1990).

Parallel processing frees a group from production blocking due to the limited channel of normal speech. Processes can be made substantially more efficient if all participants can enter their ideas at the same time rather than waiting to take turns. An additional benefit of this approach is that it prevents forgetting ideas that have to be held back while others speak.

Group memory captures a complete record of deliberation, processes, and decisions. This information can be used to review the reasons a decision was made or can be used to guide ensuing steps of longer processes. Project meetings can waste time recapping what was decided at a previous meeting. Group memory can bring the group up to speed in less time and allow members to continue to work from the point at which they left off. Group memory also has potential as organizational memory that can lead to improving the performance of the organization (Hoffer and Valacich 1993).

2.2.3 Mechanisms for Productivity

Nunamaker et al. (1993) identified four mechanisms or classes of mechanisms that can be used to improve group productivity: process structure, process support, task structure and task support. These mechanisms can work in concert to improve the quality and efficiency of decision making.

Process structure provides a working plan for a process such as establishing an agenda. The support is both at a global and a local level. The global level can be

considered the level of planning the project or meeting. The local level can be considered the level of an single activity within a meeting or process. GSS tools often allow a sequence of tools to be defined in the system prior to a meeting as a means to facilitate the groups following of the sequence. They also offer structure at the local level by keeping before participants a display of activities they need to complete such as answering a set of questions or generating ideas.

Process support assists decision-making activities such as communication or information recording. GSS tools provide discussion and organization features that automatically provide a stored record of the work done by the group. The GSS features discussed above generally fall into the process support area.

Task support assists the group by providing access to information related to the task. Individuals often bring to meetings task-related information which needs to be shared. Such information may be kept on the side as reference material or brought to the forefront for the group to edit or organize.

Task structure assists a group by providing overall organization of the problem-solving environment. For example, groups may choose to discuss root causes of problems prior to generating solution ideas. Task structure appears to become more important with greater complexity of the task.

These mechanisms can generally be introduced in a number of ways by facilitators or meeting leaders. They only become effective when this is done correctly. For example, global process structure will have no effect on a group unless someone uses that tool to set an agenda that is focused on achieving a goal.

Though these mechanisms show promise at helping groups achieve superior results in reengineering project, little work has been done in the design of processes for creating “to-be” models. The complexity of this tasks calls for not only good use of the standard GSS tools, but also the use of tools that offer greater task support.

2.2.4 Applications of GSS

GSS have been shown to be useful and robust over a wide variety of application domains. They have been used as tools in the process of organization change as well as being themselves the object of organization change. The features of GSS that lead to improved brainstorming have also been shown to be beneficial in helping groups to solve complex problems such as strategic planning that require creative problem solving (Nunamaker, Applegate and Konsynski 1987; Dennis, Nunamaker and Pranka 1991, Bostrom and Anson 1992, Tyran et al. 1992). Post (1992) conducted an extensive field study at Boeing which involved a variety of tasks including business planning, systems planning, strategy and requirements definition. These studies indicate that use of GSS improves a group’s ability to raise political issues, an ability considered important for reengineering. Other research as shown how GSS can be used to generate options for mutual gain in negotiation (Nunamaker, Dennis, Valacich, Vogel and George 1991). Such problem domains are similar to the reengineering domain in that complex, multi-criteria decisions are made by large groups of people who have strong vested interests and provide motivation to applying the technology to reengineering.

In education, they have been used to transform the classroom into a cooperative learning environment (Brandt and Briggs 1995; Brandt 1995; Walsh et al. 1996, Reinig 1996). These studies have shown how classroom processes can be improved with application of GSS, but they also show that there is a need for redesigned teaching processes to take advantage of the tools. It needs to be recognized that the tools can change the economics of deciding what is the most important type of activity to undertake. For example, discussions in classes of 50 or more do not allow each student much time to talk, thereby making discussion an “expensive” activity. Using GSS, which allow for parallel discussion, an entire class can communicate in far less time. Other studies have applied GSS to create virtual classrooms, where student learning occurs without the constraints of time and place (Hiltz and Turoff 1992).

2.2.5 Organizational Culture and Decision Making

In solving complex organizational problems, members of an organization of rely on policy or more implicitly culture. Walsh (1996) describes how a reliance on policy and culture to guide decision making when groups are faced with a changing environment may lead to inadequate solutions. Policies and culture that have developed over time from previous organizational success may not wholly apply if the organization’s competitive environment has shifted. Walsh describes how GSS can be useful in such settings by freeing decision making from the limits imposed by a culture and considering a broader class of solutions.

Image theory describes the adoption of ideas about how to address an issue as a two-step process. In the first step, screening, each idea is compared with the individual's images to see if they are reasonably compatible (the compatibility test). If not, the idea is rejected. If it survives screening, the idea passes to the second step, choice (the profitability test). Beach (1993) suggests that screening serves to eliminate implausible options, thereby reducing the possibility of a bad choice farther down the line. On the other hand, screening also may reject options that might be very good, even though they are incompatible with existing images--indeed, this may well be a sign that images need revision in light of changes in reality. These lost options can be regarded as a cost to the decision maker, and in an organizational setting the cumulative cost across a group of decision makers, each of whom is repressing possibly good ideas, may well be substantial.

When individuals, as members of organizations, consider new ideas, they do their own individual screening, using their own images of the organization. Since these images are unlikely to be the same for everyone, ideas that might be rejected by one person may be acceptable to others. Because an organization's members make decisions for it, the negative effects of their conflicting images, and conflicting decisions, can be very serious. To reduce these effects, and to give order to the many decisions that are made in its name, an organization frequently spends a great deal of time, effort, and money developing vision statements that capture the essential reasons for its existence. The goal of the vision statement process, in image theory terms, is to align its members' images of the organization's beliefs and values, goals, and plans.

Group decision making differs from individual decision making in that individuals consider the ideas and values of other group members, as well as their own. When individuals make decisions, they use their own opinions to test ideas. When groups make decisions, each member of the group tests ideas against his or her own opinions and also against his or her perceptions of other group members' opinions. If an individual regards an idea as good, but incompatible with the other decision makers, he or she may not present the idea. An individual may decide an idea fails the compatibility test based on a perception of others. These interactions are made more complex because the individuals' perceptions of the other group members' feelings are not wholly accurate.

Figure 2.5 shows the images of three hypothetical members of two different organizations; one organization has a fragmented culture and one has a unified culture. Ideas that are compatible with the central region of the overlapping images would be regarded as compatible by all three decision makers. In the unified culture, this region is larger and makes up a higher percentage of the image of each decision maker. In the unified culture, a greater percentage of ideas that an individual decision maker considers compatible will also be viewed as compatible by others in the organization.

By contrast, the images in the fragmented culture have a small overlapping region which makes up a smaller percentage of an individuals image. In this situation, many courses of action regarded as good by one individual may be regarded as incompatible by others.

Figure 2.5 Overlapping Images in Fragmented and Unified Cultures

Most organizations appear to believe that having a unified culture is good. This orientation may encourage individuals to focus on the intersection of their images and further enhance the consistency of the group while individuals in the fragmented culture may prefer to use their own images and to have less regard for the intersection of that image with other organizational members. This effect further strengthens the consistency of decision making in unified cultures. Together, these two tendencies can greatly enhance the consistency of different decision makers, but this consistency can come at a cost.

The danger for organizations with unified cultures is that their members may lose potentially profitable ideas by prematurely rejecting them. In a unified culture facing a changing environment, the likelihood of eliminating alternatives that would benefit the organization may be increased. That is, the locus of mutually acceptable ideas broadens by unifying a culture, as shown by the intersection of the images in Figure 2.5. However, the locus of ideas generated may narrow, as shown by the union of

the images. One goal of idea generation tools, using either older manual techniques or newer GSS techniques, is to allow unified cultures to make full use of their diversity when novel ideas are needed.

“From time to time, we must turn off our judicial mind and light up our creative mind. And we must wait long enough before turning up our judicial light again. Otherwise, premature judgment may douse our creative flames, and even wash away ideas already generated” (Osborne 1963, pp. 41). For organizations to gain competitive advantage from their superior ideas, they must not only generate those ideas, but also allow them to develop before subjecting them to the collective ‘judicial minds’ of the organization. This implies that, under some circumstances, screening and the compatibility test may too quickly remove ideas from consideration.

Extensive research has been conducted on the use of GSS for generating ideas and its effects on group size. In the reengineering domain, it is often desirable to allow large groups to develop ideas for organizational improvement. However, without computer support, groups larger than six or seven persons usually are not effective. In fact, manual brainstorming techniques are not more effective at generating ideas than nominal groups, groups of people working independently. However, research using electronic brainstorming, one type of GSS tool, has shown it to be more effective than nominal groups and it is particularly effective with large groups. This research also has shown that participants in GSS brainstorming are more satisfied with the outcome of their deliberations than those using a manual process (Dennis, Valacich, and Nunamaker 1990; Gallupe et al. 1992).

Groups involved in reengineering often need to develop novel ideas in a politically charged environment and previous work using GSS for strategic plan development has shown its usefulness for making significant improvements at the front end of a reengineering effort. The enterprise analysis (EA) approach to reengineering is a stream of research at the University of Arizona that has been creating improved methods of GSS use throughout the reengineering process. This stream grew out of earlier work on GSS and continues to have an impact on GSS design.

2.3 From PLEXSYS to Enterprise Analysis

Some of the early research that led to the GSS concept came from projects designed to support systems analysis and design. Nunamaker developed a system for gathering the requirements for automatically generating information systems. Previous information systems had focused on managing systems coding and modeling systems to ensure completeness and correctness. However, one of the greatest challenges in information systems development is gathering the requirements for the system first addressed by Nunamaker. He developed a system that allowed intended users of a future system to define its specification.

One of the problems with the early version of Nunamaker's system was the difficulty users had in interacting with the complex syntax of the definition language. This difficulty led to a second-generation system called PLEXSYS which allowed participants to communicate with the system and each other using unstructured text (Applegate 1986). The PLEXSYS system was built upon the concepts of decision

support systems (DSS), which aid decision makers in solving structured or semi-structured problems by providing users with decision models. These models generally are used with quantitative data. However, much relevant data is qualitative and is stored only in the minds of individuals. The PLEXSYS systems allowed groups of people to share and analyze qualitative data through selected tools. This work led to development of tools that would be generally applicable to a variety of group work situations and eventually, to the use of general-purpose tools for strategic planning (Nunamaker, Applegate and Konsynski 1988).

Enterprise analysis is a stream of research that stems from previous work and attempts to reunite support for systems analysis and design and strategic planning and apply the combination to business reengineering (Daniels 1991). The EA approach seeks to use GSS to facilitate the analysis of large scale organizations by subject matter experts (SMEs), the people within an organizations who know how it works. The EA approach seeks to develop improved organizational processes as well as to gather the requirements for information systems that will support those processes.

Daniels (1991) synthesized a number of approaches to systems analysis and design and organization improvement into the enterprise analyzer methodology summarized in Figure 2.6. The activities are not independent or wholly sequential because work on one activity may suggest reconsideration of previous activities.

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1. Preparation
 2. Vision Establishment
 3. Model Development
 4. Model Analysis
 5. Action Proposal Generation
 6. Implementation Planning
 7. Project Evaluation
-

**Figure 2.6 Enterprise Analyzer Methodology
(Daniels 1991)**

Preparation involves planning, including both high level planning for the entire project as well as the planning of individual meetings. These will undergo change throughout a project. Vision establishment aligns the participant's efforts toward common goals. Vision establishment also occurs at a number of levels since both project vision and visions for individual meetings must be established. An organization's visions are derived in part from its strategy. Model development involves modeling the "as-is" process to achieve a shared understanding of how a system is currently functioning. Model analysis is the identification of improvement opportunities in the current system. In practice it is hard to separate model development from model analysis because process evaluation happens even while the "as-is" model is being constructed. Action proposal generation is the synthesis of the model analysis into candidate recommendations which can then be compared so decision makers can make a selection from them. Implementation planning is the development of action plans, often including piloting of the selected recommendation prior to full scale deployment.

Evaluation includes review of pilot studies and other implementations and decisions on how the organization should proceed.

Daniels notes that one significant limitation of previous systems development support tools such as CASE tools is their single user orientation. This is a poor fit in a problem domain that needs the joint effort of a number of individuals and easily becomes a bottleneck in the process. An enterprise analyzer project seeks to develop group support for systems and process analysis and design. Daniels's model is shown in Figure 2.7, which shows the need for tools and data to be accessible throughout the project by different people working in different modes.

Figure 2.7 Enterprise Analyzer Interaction Model (Daniels 1991)

Early work on the EA approach revealed that general purpose GSS could be used for enterprise analysis, although, the limited task support of currently available GSS hindered the process. EA researchers therefore began to experiment with tools that

combined the features of tools that offered single-user task support with features that offered group-process support.

One single-user modeling technique that has been used for organizational analysis is IDEF0. The EA researchers expanded its usefulness by developing a GSS called Modeler that allows groups of SMEs to develop IDEF-0 models. Research indicated that, with proper tool design and facilitation, large groups of SMEs who had had minimal training on the modeling techniques could develop complex business models. It has been found that graphical modeling languages were useful for helping people understand business process, but hard for groups to use to develop the models. Modeler allows SMEs to enter business activities in a textual hierarchy and also to view computer generated graphical representations of the model they have entered (Dean 1995).

The EA researchers found that “The number of participants who can be effectively supported appears to be significantly increased with the EMS-supported approach” (p. 189). Dean theorizes that increased participation and decreased model development time will likely benefit the overall analysis effort by improving model quality and participant ownership.

Another project within the EA approach was the development of tools and processes that support group data modeling (Lee 1995). These systems are useful empowering users to define system needs from a data perspective. Although this approach appears to be significant enhancement to other software development paradigms, it was not intended to address process change. It is likely that these systems

would be useful for systems development efforts that may be conducted in conjunction with reengineering.

One limitation of EA research stems from its focus on the IDEF0 modeling technique. While IDEF-0 appears to be a good technique for capturing a high-level model of a business process, it lacks details such as determination of the timing and sequence necessary for more thorough process analysis. The next section summarizes research using simulation to focus explicitly on analysis of timing and sequence, a potential new component of the EA approach.

2.4 Simulation and Animation Research

2.4.1 Simulation

A simulation is a dynamic model of a system or phenomenon that can be used for analysis, training or problem solving when the real system cannot be used directly or when the cost of using the real system is excessive (Mayer and Benjamin 1992). Simulation is often used to compare systems to see which performs best or to find the best value of an input to a system. Simulation was once considered the problem-solving method of last resort because optimizations based on mathematical formulas were more efficient when an optimal solution for the model could be found. When formulas could not be optimized analytically, then simulation could be used. The use of simulation goes “back at least to the eighteenth century” (Kelton 1994, p. 1) when human “computers” were used, but it has become significantly more useful when electronic computers can

be applied. Simulated war games have been used for at least hundreds of years and did not rely on computers. Today, simulation is becoming the method of choice in some fields as the cost of computer processing falls and researchers make better use of simulation's inherent benefits such as intuitive relationships with the real world.

The simulation modeling domain includes a wide range of methods and may or may not use a computer. Although, computer simulation may use analog or digital computers, analog computers are little used today. Using computer simulation in modeling comprises three basic elements, the real system, the conceptual model and the computer simulation as well as two basic relations, the modeling relation and the simulation relation, as depicted in Figure 2.8 (Zeigler 1976). It should be noted that the real system indicates the system under study even if that system does not currently exist. In the case of designing a new system, the real system actually is to a planned system.

One useful simulation method for business engineering is digital computer based discrete event simulation, which allows for the simulation of processes that change state

at discrete intervals. Even though real processes generally operate continuously, a discrete model is often a good approximation. These models are generally stochastic in that event duration and arrival time can have probabilistic values.

One frequent use of discrete event simulation has been in the area of production processes design, where it is often used to test and design factory layouts. Mayer and Benjamin (1992) showed how discrete event simulation could be used with the Taguchi method to design production processes that are tolerant of variance. More recently, simulation is being used for administrative processes such as expense report processing, as shown by (Levine and Aurand 1994).

Simulation is beginning to be applied to more abstract issues such as organizational structure, as shown by Jin et al. (1995). This stream of research often uses mathematical or heuristic-based techniques to model an organization in aggregate. A mathematical approach develops a system of equations that model certain organizational performance characteristics. Parameters in the equations can represent alternative organizational designs. The heuristic-based approach attempts to develop a causal model of relationships between organizational factors. These models, often used to represent well developed organizational theories, apply only to high level aggregate design options. A third method is a model based approach which models causal behavior at a micro level to examine alternative organizational structures, technologies or operating procedures. Another differentiating feature in micro-level analysis is the premise that organizations do not make decisions, people do. Jin et al. (1995) shows how the model-based approach can be used to model the behavior of the virtual design

team. Their model is implemented with discrete event simulation. This approach is at a higher level of abstraction than process modeling. While it may give better insight into organizational design than the heuristic-based model approaches that do not model the behavior of individuals, it nevertheless does not allow for modeling processes. This approach appears to focus on high-level parameters such as the availability of voice-mail and therefore tends to influence policy decisions. It appears most useful for improving the performance of an organization or a department, but this is precisely the type of analysis that reengineering experts warn against. Business process simulation is a less used method, but it is consistent with the level of analysis that is recommended by reengineering experts.

2.4.2 Visual Interactive Simulation

Visual interactive simulation (VIS) is a controversial stream of research that focuses on the analysis of simulation through visual interaction by non-experts. These systems allow participants familiar with the problem domain to interact with an animation or simulation to change parameters and explore the output. This method of analysis does not rely on a formal understanding of simulation modeling and only a subset of the models parameters usually are provided to the user to simplify interaction.

The method is controversial because of its lack of formal analysis. Some may consider this use of technology irresponsible when experimental guidelines for simulation and mathematical model analysis are readily available. Most seem to agree

that visualization has value for model validation. The controversy centers primarily around analysis.

Hurriion and Secker (1978) proposed that visual interactive simulation is useful for bringing decision makers closer to problem solving techniques than simulation alone. Simulation is generally a “black-box” to decision makers. When simulation results do not agree with decision makers’ intuition the gap that occurs is not easy to resolve. Visual interactive simulation also can help analysts see where problems occur. Hurriion and Secker recommend parallel development of simulation and visualization rather than sequential because parallel development helps begin validation of the model and can highlight bugs in the software.

Bell and O’Keefe (1995) investigated the impact of VIS on user performance. In their study, users developed better solutions to the assigned problem after interaction with the animation. However, they did not achieve an optimal solution that could be tested through traditional simulation experimentation. The experiment used a well structured problem in which the subjects were asked to change simulation parameters. Bell and O’Keefe posit that if the problem had been a more complex real world problem, the simulation expert might not have known what parameters could be changed and been forced to rely on the judgment of the decision maker.

The VIS literature is interesting in its demonstration of concepts that could benefit process design. However, little empirical evidence yet exists in support of its assertions.

2.4.3 Presentation Support

Vogel (1986) studied the use of computer support for persuasive presentations. The directly applicable finding of this study was “presentation support has a strong direct impact on comprehension and retention” (p. 178). This suggests that computer support for presentations of “as-is” models will help groups understand the process. It should also help with the presentation of “to-be” proposals. Vogel’s study also found that computer support influenced participants to take action an important goal of most reengineering plans.

2.5 *Business Process Simulation*

Meel (1993) explored the use of simulation and animation for business engineering (BE) and demonstrated a problem solving methodology for its use. An overview of his dynamic modeling approach to BE is shown in Figure 2.9. This model is based on problem solving approaches that have been adapted to the BE domain. He also demonstrated the benefits of using simulation to reduce the cost of experimenting with alternatives in comparison with an actual implementation. He identified seven techniques for generation of potential alternatives: heuristic search, joint modeling sessions, model analysis, theories and principles, idealized design, generic examples, and dialectical debate (see Meel 1993, table 7.2).

The dynamic modeling approach to BE requires the development of both conceptual models and empirical models of the process under investigation. The translation of the conceptual model into the empirical model requires a number of

transforms that ensure a valid translation while still using programming and computer resources efficiently. Vreede (1995) demonstrated systematic transforms that can be used to move efficiently from the conceptual model to the empirical with no (or limited) loss of validity. Vreede also noted the need for stakeholder participation and used GSS to support it. He noted the need to use both qualitative and quantitative data to understand BE problems.

Eijck (1996) further elaborated the BE methodology as described by

Figure 2.9 Overview of Business Engineering Approach (Meel 1993)

Meel (1993) and mapped available technologies to the steps. In order to close the conceptual gap between the conceptual model and the empirical model, Eijck proposed an object-oriented empirical model that maps closely to key concepts in the conceptual model. The four primary objects making up this model are the actor, the repository, the link and the item. These objects were prototyped in a template of Arena.

2.6 Chapter Summary

The reengineering literature provides compelling evidence the reengineering is necessary, however, it gives little insight into how to do it. The characteristics of reengineered processes that have been identified give clues to the paradigm shifts in organization design and may help give designers ideas they can apply, but are inadequate for helping organizations create new process models. This dissertation documents the use of support tools to help an organization design a “to-be” process model.

CHAPTER 3 THEORETICAL FOUNDATIONS

This section develops the theoretical foundations that guided the work. The most applicable theoretical paradigms were selected from the literature review and interpreted for the needs of this project. This research tested the applicability of the focus theory of group productivity as applicable to the design of reengineering projects and the selection of supporting tools. Though focus theory was the central theory considered, the complexity of completing a reengineering project in a real organization required us to consider other theories as well.

Although focus theory describes how groups solve problems, in this case reengineering, it can be unclear which of the many support technologies should be used. The GSS research framework considers a number of factors that effect group processes such as problem solving and provides additional insight into technology selection. Additionally, a broad range of empirical evidence has been published within its framework. Therefore design decisions were made that appeared consistent with focus theory and much of the empirical data related to the GSS research framework.

3.1 The Focus Theory of Group Productivity

Focus theory is a general theory of what makes groups productive. Developed by Briggs (1994) for the purpose unifying the large number of disparate models of groups and technology currently found in the literature, it was designed to predict the effects of

new untested technologies. The constructs and relationships of focus theory are shown in Figure 3.2.

Figure 3.1 The Constructs of Focus Theory (Briggs 1994)

Focus theory revolves around its central constructs of group problem solving. It suggests that for groups to solve problems they must deliberate, communicate and access information. Each of these functions requires cognitive effort on the part of participants and detracts from their ability perform the other functions. Figure 3.2 represents relationships between functions, as shown by two way negative influence arrows.

Motivating the cognitive effort required for problem solving is goal congruence, the degree to which individuals' goals are consistent with each other. If individual goals

are in opposition, a group is likely to be unproductive, with individual members working against one another.

The added value of using modeling techniques for problem solving also can be described in terms of focus theory. Using a model, one can focus on only the relevant information, reducing the costs of information access over what would be needed to access raw, unmodeled data as well as of communication between participants in group problem solving by providing a common framework for discussion and decreasing distractions. These reductions in cognitive load can then be translated into more effort being available for deliberation.

GSS provides support for problem solving by reducing the cognitive effort of communication, deliberation and information access, therefore GSS should be able to make substantial impact on the productivity of groups undergoing reengineering. In particular, groups who are trying to discover innovative ideas for process improvement should be able to expend greater energies for thinking of new ideas if they do not have to spend as much energy communicating and storing those ideas.

In applying GSS to helping groups generate improvement ideas it appears clear that it can improve communication and deliberation, but not features in today's GSS provide support for understanding the complex dynamics of organizational processes. It appears that GSS support for information access may be a weakness in the reengineering domain. It is therefore reasonable to supplement GSS with additional support focused on mitigating this weakness.

A promising technology for supplementing GSS is animated simulation. Though this technology is not group enabled, it provides functions that directly complement GSS in the design and analysis process. It is therefore proposed that the combined use of GSS and animated simulation will improve a group's ability to design "to-be" models.

The first proposition of this study is:

- **Proposition 1: Focus theory is a useful theory for applying new technology to novel problem domains.**

Following the implications of focus theory, we selected GSS and animated simulation to help an organization develop "to-be" process models. The second proposition is:

- **Proposition 2: GSS and animated simulation can help reengineering project teams create "to-be" models.**

However, testing these propositions assumes that GSS and animated simulation are applied well. As Bostrom and Anson (1992) noted, GSS only has beneficial effects when applied with proper facilitation and can have detrimental effects when applied poorly. Current knowledge about using technology to support reengineering processes is still in its infancy, therefore tests of the propositions stated above is still somewhat premature. This study remains exploratory and will attempt to discover how the technologies can be applied best. Evidence related to the proposition will be collected, but it is not expected to be conclusive. The overriding research question is:

- **Research question: How can GSS and animated simulation be used to help groups create “to-be” business process models?**

3.2 GSS Theory

Dennis et al. (1988) proposed a research model for GSS that synthesized earlier GDSS and CSCW research, as shown in Figure 3.1. This model has proven to be a useful framework for GSS research, and many researchers continue to describe their work in its terms. It should be noted that a wide variety of constructs affecting process have been identified by different researchers, however, only those relevant to this study are included.

Figure 3.2 GSS Research Framework (adapted from Dennis et al. 1988)

Benbasat and Lim (1993) conducted a meta-analysis of moderating variables in GSS research from which a number of principles can be derived for use in such systems. They found that GSS use has greater effects for large groups, greater satisfaction effects for face-to-face groups and greater increases in the number of ideas generated and level of satisfaction for non-hierarchically organized groups. However, they found that GSS use was more effective for less complex tasks. They attributed this finding to the incompletely developed abilities of the technology to integrate multiple steps in a multi-step task.

The term group relationships refers to a number of related group characteristics, including history, motivation and expectations for the future.

The GSS environment is the mode and facilities in which a system is used. In face-to-face mode, a GSS is usually a set of networked PCs arranged to facilitate computer work and verbal communication. In distributed mode, the GSS may be a networked computer in an individual's office and may or may not support audio or video channels in addition to computer support.

The central construct, process, is critical to understanding how to achieve the benefits of GSS. Simply using a GSS with a group that has group work to accomplish does not ensure improved productivity. The process of GSS use must be designed and facilitated.

Nunamaker (1991) has described GSS as providing both process support and task support. One can see from the research model in Figure 3.1 that much of GSS work has focused on process support. I believe that a complex task such as reengineering will

benefit from additional task support, beyond that provided by current GSS. Modeling tools are designed for task support and should be helpful.

The research model shown Figure 3.2 has implications for the design of the reengineering process used in this study as well as the research approach. Process design needed to consider the contingent factors in the model and the research approach had to document the constructs in the target organization in order to understand the study's generalizability.

Benbasat and Lim's (1993) finding that GSS had greater effects on less complex tasks was not considered as reason for avoiding GSS for the highly complex task reengineering. It was however, taken as a warning that process losses may occur between tasks or for tasks unsupported by the technology. We intended to mitigate those task by anticipating them through planning and applying available technology where possible.

GSS research has demonstrated strong support for the ability of GSS to improve tasks involving large numbers of participants. This finding led to efforts in the study to involve as many process experts as possible in the reengineering process. A larger number of participants seemed likely to improve the process by bringing to it more information and more creative solution ideas. Given the size of the organization selected for the study, the potential number of participants was within the effective range of participation studied previously.

The project addressed a number of tasks extending over time, allowing for the use of a variety of GSS environments. The choice of environment for each task was a design issue.

Recommendations of Daniels (1991) guided the overall project. Though Daniels considered joint undertaking of business process design and systems specification, his methodology appears robust. However, tools were substituted, as appropriate, to support the domain currently under study.

3.3 Visualization

Visualization research implies that its techniques can alleviate the difficulty of generating insight into process problems. Interaction with models previously has been limited to participants' being able to change model parameters. This type of interaction is of little value in reengineering, where changes to the structure of the model are sought. Rather than having the functional experts interact directly with the system, visualization can be used to contribute to presentations to functional experts who will be asked to generate improvement ideas. As needed, experts can program those simulations that functional experts deem useful for better understanding of the problem or to test expected performance of changes. Recognizing that current interaction technology does not support user interaction in a way that allows the user to make structural changes to the model, but only allow the user to change parameters or choose from structures already programmed. It has been the intent of this research to uncover potential structural changes beyond those an analyst has perceived.

3.4 Chapter Summary

Though this set of theories was expected to be tremendously helpful in guiding our work, we realized that the fundamental issue of how to design a fundamentally new processes has not been addressed in previous work on reengineering. Although focus theory can guide group problem solving approaches, of which this is one, it did tell us how we could find inspiration for new processes. It did suggest that we needed to provide appropriate information and to use technology effectively to manage communication and problem complexity so that participants could devote their full attention to the problem.

The work of Dennis et al. (1988), Daniels (1991) and Briggs and Nunamaker (1995) has significant implications for the conduct of reengineering using computer support. Lessons learned from each of these studies were used in the design of the project, though they will be interpreted for the reengineering context.

The research model shown Figure 3.2 has implications for the design of the reengineering process used in this study as well as the research approach. Process design needed to consider the contingent factors in the model and the research approach had to document the constructs in the target organization in order to understand the study's generalizability.

CHAPTER 4 RESEARCH APPROACH

I contend that many advances in science and engineering and society in general have resulted from building real systems or components and then observing field or laboratory experiments that prove they work. The process of discovery is a valid scientific method...

...Today we have aeronautical theories so rigorous that every parameter affecting the flight of an aircraft can be mathematically predicted. Indeed, Boeing Corporation is now engaged in designing and building the 777, and this plane, the most complex civilian flying machine ever developed, will be prototyped entirely within the memory of the computer. There will be no physical prototype. Yet when the Wright brothers flew, none of this theory had been developed. They learned about aerodynamics literally by the seat of their pants, and the proof of their concepts came when the plane lifted above the sands of Kittyhawk. None of the theory driving the simulation of the 777 would have been developed if people like the Wrights hadn't spent a great deal of time building airplanes. (Nunamaker 1992, p. 1)

This dissertation follows the information systems research approach as recommended by Nunamaker (1992; see also Nunamaker, Chen and Purdin 1991). Previous theory has suggested that GSS and animated simulation are useful tools for helping groups develop insight into ways to improve their organization, but little is known about how these tools can be used within organizations to capture and model this insight. To fully understand the impact of GSS, a multi-methodological approach is required (Vogel and Nunamaker 1990). Research cited in Chapter 2 has demonstrated significant benefits of GSS use in laboratory and field situations in a variety of domains related to organizational decision making. However, little has been done in the activity of creating "to-be" models, a significant step in reengineering. Therefore it is appropriate to conduct an exploratory investigation applying GSS to the under-studied

domain of reengineering. Therefore, this dissertation describes a study that focused on field research in a real organization.

Reengineering seeks to change human behavior, therefore, this research method aimed to be assertive rather than passive and to take a normative perspective in that it sought to improve the organization under study. Any reengineering research that is conducted outside of real organizational settings, where the participants have no history or shared context and do not expect to live in the new organization they are trying to create, is open to questions concerning external validity. Action science, a field methodology that addresses such concerns while attempting to improve social systems, was followed in this study. Within the action science methodology, case study methods also were applied.

Orlikowski and Baroudi (1991) argued for adopting more diverse research methodologies in the study of information systems such as has been done in other domains of social research such as anthropology or industrial psychology. They noted that less than 1% of published information systems research used an action science methodology and only 4.5% of all studies were longitudinal. This study sought to expand the methodological norms of information systems research to help balance the current perspectives.

Because action science has the goal of improving theory as well as improving the object of the study, both a research methodology and methods of practice were used. This chapter primarily describes the research methodology, however Section 4.5 describes the methods of practice employed.

4.1 An Information Systems Research Approach

Information systems research approach as recommended by Nunamaker (1992) is shown in Figure 4.1. Central to this approach is the development of theory. Since theories can not be proved, confidence in them can only grow as they are tested and modified through repeated study. Early in the study of a problem domain, the theory may be referred to as a concept. The concept is a vision for the ensuing research that is developed to test and enrich understanding of the concept.

In applied fields, such as management information systems, theory testing must be conducted in both laboratory and field settings to gain confidence in its validity and significance. Theories only tested in the laboratory may demonstrate relationships that are not applicable to real-world situations where other factors may dominate the

situation. Theories only tested in field settings may lack confidence in causal relationships due to lack of control of concomitant constructs.

Like other fields of research that involve design, information systems research can require the development of prototypes. Often, new concepts cannot be adequately tested without a properly functioning information system. An iterative approach is necessary because what constitutes a properly functioning information system for a new concept is not fully known *a priori*.

This research is a component of a research stream that revolves around the new concept of collaborative reengineering. As such it focused on a field study and development of improvements to current theory. It allowed for development of implications for the creation of new systems and lab studies that will be useful for better understanding the reengineering concept.

In terms of prototyping, this research was not intended to develop new software. However, it was necessary to assemble a collection of existing software and to use it in novel ways to support the process. In this sense, a prototype system was to be developed.

Previous GSS studies have shown that field studies and laboratory studies can yield conflicting results (Nunamaker et al. 1989). These conflicting results may be attributed to the difficulty of reproducing the task complexity and participant vested interest that are found in real organizations when they attempt to solve real problems. The task of reengineering is indeed complex, including as it does participants' intuitive knowledge of strategy, technology, and the environment as well as conflicts of interest

between individual goals and organizational goals that may occur. It is therefore critical that these phenomena be studied in field settings and with a clear understanding that useful laboratory experiments can only be designed when it is recognized what really matters is making the process effective.

Groups used in experimental situations differ from those found in organizational life, where members have pasts and expectations for futures as well as established patterns of interaction with each other. They not only participate in teams, but they also make decisions whether or not to form or participate in teams (McGrath 1984). Their tasks are not independent, but rather are components of larger projects which also interact with each other and make up a thick web of activity that constitutes the organization. It is reasonable to assume that these differences may affect the results of reengineering studies done in the laboratory versus in the field, so it was decided this would be a field study focused on having strong external validity.

Our theory suggests that process animation can reduce the cognitive load of understanding processes and that GSS can reduce the cognitive load of groups developing ideas. It is therefore reasonable to believe that if these technology were to be used together, appropriately, groups would do a better job of generating insight into “to-be” business models. However, it would be premature to isolate these variables in a laboratory setting without having reached a better understanding of the critical aspects of generating insight in real organizational settings.

The choice of qualitative data or quantitative data should be based on the research issues rather than ontological beliefs (Morgan and Smircich 1980). This study

used qualitative data about the processes of reengineering and users' responses to insight generation techniques. The emphasis was on how to use the techniques and whether or not they can be applied rather than on precise measurement of their benefits over other techniques.

4.2 Action Science

Action science can be seen as spanning the gap between theory and practice. It is useful when applying theories of how people behave to real-world social systems where all outcomes are not predictable, particularly when it is desirable to change the behavior of participants in the system under study. In such real-world situations the researcher is guided by a number of theories, some explicit and some not, on how to approach the problem. In fact, meta-theories on how to choose a theory for a situation are needed as well (Argyris 1985).

In this type of situation the researcher must draw upon knowledge, often tacit. It is from understanding how the application of both types of knowledge works and does not work that new knowledge and modified theories develop. Researchers must undergo self-examination at times to draw out the theories that guided their actions if they are to understand what unspoken knowledge was used. It is this self-reflection and feedback from the system under study that helps to create new knowledge. The researcher using this methodology is generally an expert in the field, but it is the reflective link back to theory or established practices that separates the researcher from the practitioner.

In action science much can be learned from failures, but this learning is best understood in the light of subsequent triumph. In the day-to-day conduct of action science, there are apt to be mistakes in judgment that lead to unintended consequences. Much can be learned by following an approach that does not pan out with another that is more sophisticated, enhanced by what was learned in the failed attempt. In this sense action science is iterative. It attempts to apply current theory. When the theory does not perform as expected, it can be modified or cast aside in favor of a more applicable theory.

This study question focuses on how to use technology for the purpose of reengineering. The goal of the study is to understand the efficacy of such an approach in the real-world environment and therefore some loss of control of unfolding events is considered reasonable. Yin (1994) recommends the case study approach for this type of research. However, action science differs from case study in its interventionist nature. Case studies usually do not seek to change the system under study whereas action science studies usually intend to change the system.

The active participation by the researcher has two primary benefits to the study. First, and foremost, is that the researcher may want to bring together phenomena that do not naturally occur in the environment and therefore could not be studied with a passive approach. Second, the control the researcher has over events can help establish natural controls that add validity to the findings.

This first reason was a driving criterion for selecting the action science methodology in this study. The use of GSS and animation for the purpose of

reengineering is not generally used by organizations. These technologies are highly specialized and require trained experts to be used properly and therefore many organizations would not have access to their use. Case studies can be useful when leading edge companies attempt to go beyond others in applying technology, but often studies can not be performed until much commercialization has occurred.

Therefore, case studies have a weakness in that they only study phenomena that has occurred or is occurring over its own initiative. This is limiting in that some useful phenomena may never occur. In the action science paradigm, the researcher is attempting to match contemporary problems with potential solutions or improvement methods, thus creating a phenomena that may have never occurred otherwise. This matching of problems and novel problem solving methods is not a random process. Past research on how problem solving methods have benefited problem solving in other domains is used as a guide. However, in matching a problem with problem solving methods, the action science researcher must exercise a good deal of creativity to re-frame methods and perhaps modify methods to suit the target domain.

The second advantage of action science over case study is that natural controls can be better exploited. Orlikowski and Baroudi (1991) and Yin (1994) discuss the use of natural controls in case studies. A natural control is a situation where a subject is observed in two or more conditions where only a limited number of factors vary between the situations and isolation of the causal factors can be determined. Using an action science paradigm, it can be possible for the researcher to manipulate the environment in way that causes quasi-natural controls. The term quasi-natural control is

used to distinguish this phenomena from truly natural controls that occur by chance. However, the are more natural than controls used in field experimentation where explicit treatments are determined a priori.

A limitation of action science, as well as case study, is the lack of control which can misplace causal relationships. Another limitation of action science, not seen in case studies, is that findings may be hard to generalize to situations where the researcher is not intervening. However, the strength of action science to cause useful phenomena that may not have occurred otherwise is so critical to the development of knowledge that its limitations must be endured.

4.2.1 Dynamics of Action Science

Meel (1993) describes the need for flexibility when study business engineering in the real-world context. He states that “dynamic phenomena demand flexible adaptation and change” (p. 175) is a ‘hard core’ assumption for both the problem domain of business engineering and the research domain that attempts to understand it. It is likely that the dynamics of the organization under study will alter the course of the research process. However, it is ongoing changes that make the problem of reengineering so difficult, and investigations that are conducted in settings protected from these changes may have limited external validity.

4.2.2 The Cycles of Action Science

The action science approach requires cycles of planning, acting, and evaluating and these cycles are recursive. While in one stage, such as acting, one is likely to go through the full action science cycle at a smaller scale.

The cycles of action science are shown in Figure 4.2. There is no implied beginning, however, for exposition it is convenient to begin with review theory. Reviewing theory is the search for theories that are expected to be useful guides for predicting the effects of action. Designing intervention applies the selected theories to the particular situation in a way that is expected to evoke the desired response from a system. After the intervention is designed it is applied to the target system. Then the consequences of the intervention are evaluated. The evaluation can imply moving to any of the other stages depending on the related evidence. Should the theories prove wholly inadequate, this step might be followed by a new theory review. If the theory appears applicable, but the desired consequences were not achieved, the intervention may be redesigned. If the theory appears somewhat useful, it may be modified. In any case, a new intervention should be applied so that changes to the consequences can be noted.

4.3 A Longitudinal Approach

Much GSS research has focused on single session meeting; less has been done on longitudinal studies of projects or organizations (Nunamaker et al. 1992). This study took a longitudinal approach to understanding how a variety of tools can be used during

the course of a project with group members participating in a variety of modes as needed.

Figure 4.2 Action Science Cycles

Van den Ven (1986) argued for the need for longitudinal research on the management of innovation. His definition of innovation, “the development and implementation of new ideas by people who over time engage in transactions with others within an institutional order,” (p. 590) fits well with the concept of reengineering. He argued that the four basic concepts should be considered when studying innovation: ideas, people, transactions, and context.

4.4 Study Procedures and Validity Tactics

Though the case study method differs from action science in its usual lack of an interventionist component, its procedures are often applicable to action science studies. The procedures were designed around tactics for increasing the study's validity as described by Yin (1994).

4.4.1 External Validity

External validity was strengthened by the selection of a real organization that had identified the need for reengineering prior to the study and through the use of off the shelf software. The organization had recently undergone strategies planning exercises that indicated that it needed to make dramatic improvements to its processes to be competitive. The organization can be classified as being in the service industry though they produce and manufacture software as well as provide services. The manufacturing of the software packages consumes only a small part of their operating costs.

The setting for the study was in the organization. The espoused intent of the organization was to make improvements to its processes and participants were aware of the intention and therefore believed that the project was intended effect the organization and was not just an "academic" exercise. Though, their belief in the projects potential varied. The participants of the study were the individual who's processes were expected to be effected. It is the belief that the project will have an impact on the individual that creates a level of vested interest in the process that is difficult to create in the laboratory.

Only commercially available software was used in the reengineering process indicating that the software was not developed for this particular organization.

Generalizability of findings can be limited in a single organization study. However, the weakness was endured for the purpose of understanding the organization and the process in detail. To the extent that this organization is representative, results are likely to be transferable to other organizations. Difference in other organizations may change their results. The rich study description was developed to guide generalizability and determine characteristics that might be varied in future studies.

4.4.2 Reliability

The goal of reliability is to ensure that another researcher undertaking the same study, following the same design, would come to the same conclusions. Reliability was enhanced through the use of a case study protocol and a study database. The protocol was used to document planned and actual procedures and was stored in the study database along with other information. The primary study database used was Lotus Notes which provided researchers with distributed access and natural backup.

The major phases of the study were designed and documented in the protocol at the beginning of the study. The details of each phase were designed near the beginning of each phase, incorporating what was learned in the previous phase or adapting to the schedules of members of the target organization. The protocol was by flexible, allowing the researchers to take advantage of critical events as they unfolded. However, plans, changes to plans, and actual events were all recorded.

The protocol, field notes, and other information was stored in a Lotus Notes database. The GroupSystems GroupOutliner template was used for the structure of the Notes database. The GroupOutliner template is one of the Notes structure definitions that are provided with GroupSystems to provided interoperability. Therefore, the Notes database could be exported from Notes and imported to GroupSystems for face-to-face research project review meetings. The GroupOutliner template provided a hierarchical structure that could be built to and arbitrary depth which provided flexibility for a variety of ill structured data collected throughout the study. The high-level topics used in the outline are shown in Figure 4.3.

The literature review topic was used as an annotated bibliography during the early stages of the literature search. The annotation were used to

-
- Literature Review
 - Project Reference Information
 - Project Plan
 - Research Questions
 - Project Field Notes
-

Figure 4.3 Research Database Topics

document the items relevance to the study. Once the study was underway and the literature review formally documented as presented in Chapter 2 of this report, subsequent revisions were made directly to the report.

The project reference information topic was used to store miscellaneous reference information and included the following sub-topics: project people, dissertation description, field note procedures, artifact catalog, and definitions of terms. The project people section documented both researchers and subjects of the study and included contact and nickname information. The nickname information was used as a shorthand reference in field notes. The dissertation description was a short description of the

project used to describe the project to interested parties such as the subjects or others in the target organization. This description was used by all the researchers to give a clear and consistent view of the project. The field note procedures documented the standards for making and storing field notes. The artifact catalog provided a reference and a description of all artifacts collected or generated by the study. It included reference to both paper files and computer files. The last topic, definitions of terms was used to document ambiguous study specific terms, particularly those that may be interpreted differently in another context.

The project plan topic was used to document the study plan and changes to it. The plan was updated throughout the study. Action items were coded as to whether they were completed, postponed, or canceled.

The research questions topic listed research the research questions of the study and linked them to the pieces of evidence that could be used to evaluate them. It also documented new questions that appeared important in the study that had potential for future work.

The project field notes topic contained two types of organizations, chronological and topic. Observations were first recorded in the chronological organization where a separate sub-topic was created for each date. The topic area was used a first attempt at understanding the field notes and observations that directly related to the topics were recorded in this area as well. Note the topic area contained less detailed field notes and was, in some instances, used a link to the relevant chronological notes.

4.4.3 Construct Validity

Multiple sources of evidence were used to strengthen construct validity.

4.4.4 Internal validity

Pattern matching, explanation building and natural controls were used to strengthen internal validity.

4.5 Methods of Practice

4.5.1 Enterprise Analysis

Given the above theories on the value of tools, it is still necessary to consider how to organize and support a reengineering project. Daniels (1991) identified a methodology and a set of support tools that are useful for enterprise analysis.

4.5.2 Simulation Methods

The methods used for development, validation and experimentation with simulations have been have been developed over many years through the use of simulation in a variety of domains. Their history can be informative to contemporary users of simulation for reengineering, but simulation practice remains, to some extent, an art.

The use of simulation in process research requires two steps: simulation coding and experimentation. After conversion of a conceptual model into a computer language, experiments must be designed and carried out. This involves setting the experimental

conditions, running the simulation for a number of trials, and analyzing the output. Research in both of these areas has improved the efficiency and validity of the method.

Research on simulation languages has developed a variety of tools ranging from additions to other problem-solving programs such as spreadsheets and extensions of programming languages to stand-alone simulation programming languages. Another approach is to develop simulation program generators which take a simulation definition and convert it into the source code of a programming language as was done by Shearn (1990) in demonstrating a simulation program generator that generated Pascal. A history of simulation software development is given by Nance (1993).

Research on simulation experimentation has developed methods of verification, validation and treatment analysis. Verification and validation is the comparison of the model to the real world phenomena being modeled to determine whether or not the model accurately portrays the phenomena. Definitions of verification and validation in the literature are not always consistent. I will follow Kleijnen's (1995) recommendation and use Law and Kelton's definition (1991, p.4): "Verification is determining that a simulation computer program performs as intended, i.e., debugging the computer program... Validation is concerned with determining whether the conceptual simulation model (as opposed to the computer program) is an accurate representation of the system under study." This definition is consistent with the element and relation breakdown by Zeigler (1976) shown in Figure 2.8. Verification refers to the simulation relation while validation refers to the modeling relation. Treatment analysis measures differences in model behavior under different experimental systems. This relation is not shown in

Figure 2.8, but corresponds to a comparison of two computer simulation elements that are related to different real systems. One difference between the two is that in verification one can strive for an exact or perfect relationship between the conceptual model and the computer simulation, while in validation the conceptual model is necessarily an abstraction from the real system and cannot be an exact representation (Kleijnen 1995). Kleijnen (1995) reviews methods of verifications and validation.

4.5 Chapter Summary

This research is one component in a program of research guided by the software development framework. It attempted to apply recently developed theories and software tools to the process of developing “to-be” models for an organization in need of change and was intended to have an impact on the target organization in expectation that a full reengineering project would be undertaken, rather than isolated exercises in “to-be” model generation. However, the process of “to-be” model generation appears to be so closely tied to the vested interest of the individuals involved that it is impossible to attain the same level of external validity in an experimental or otherwise contrived situation.

CHAPTER 5 TARGET ORGANIZATION

The target organization, a software development company, was selected because of its identified need for dramatic process improvement. The board of directors had just finished a strategic planning project in which its members had identified financial goals and competitive threats.

5.1 Organizational Overview

The target organization is a software development firm specializing in the development of multi-user communication software that was started as part of a major southwestern university's technology transfer program, intended to transfer university research to the private sector.

5.1.1 History

Early research in one of the computer related departments within the university involved support for software development, including tools to gather software requirements from end users. Researchers developed software that enabled members of an organization easily to list the requirements for a proposed software development effort. These tools were later developed into ones that could be used much more generally by groups undertaking to solve problems.

By the time the software had been developed to the point that it was ready for commercialization, state and federal laws had recently been amended to facilitate the

start-up of commercial ventures by universities allowing the transfer of the fruits of research to the public sector. With help from a contract from a major customer, the university established the company.

The company's first product was an MS-DOS based version of its communication/ decision support software. Three years later, the company released results of a major undertaking, a Microsoft Windows version of its software.

Now in its sixth year, the company's growth primarily revolved around expanding its customer base for its core product, in both its DOS and Windows formats. Recently the company had expanded into consulting, helping customers apply the tools. A number of tools that extended the collaborative concept of its software also had been developed including a group drawing package, a distributed questionnaire tool, and a group activity modeling tool that adheres to IDEF0 modeling standards. Currently these products constitute niche products.

The company's customers were largely major US corporations, however, sales were increasing to government and foreign companies. Also, the company has aggressively supported research use in universities.

5.1.2 Current Strategic Position and Challenge

In mid-1995, the CEO began to build a strategic plan with the help of a management consultant, financial advisors and the management team. One of the goals of the CEO had become to build the organization to a size making it attractive for taking the company public or being bought. His financial advisors suggested that the

organization needed about three times the level of sales and a more efficient use of labor, based on revenue to labor ratios. The CEO and his advisors concurred that the company needed to attain this level of growth within three to five years because of competitive threats.

As an example from another high-tech high-growth company, Silicon Graphics had achieved a revenue to employee ratio of \$307,000/employee (Prokesch 1993), about three times this company's level.

The customer base of the organization was growing at 50% per year, but due to falling prices of its software product, revenue was growing more slowly. The software industry is notorious for rapidly decreasing sales prices and the largest supplier, Microsoft, is known for fiercely devouring market share when it enters new segments. The company was enjoying relatively high software prices because of its unique position as a pioneer in the field, however, the growing popularity of the software was beginning to garner competitor interest. It was conceivable that a major software producer may introduce a competing product for less than one tenth the price. However, an even greater threat could be from a competitor who adapted more quickly to a critical paradigm shift in communication software known as the World Wide Web (WWW).

5.1.3 Technology Paradigm Shift: WWW

At the same time the company was assessing its goals, dramatic increases in the use of the WWW began to change the software development playing field, particularly in the area of communication systems. The WWW technology offered the potential for

any individual in nearly any organization in the world to share information. Previously, this type of communication related software often had been developed for local area networks (LAN) or mainframe computers, options that tended to limit participation to the organization owning the software and often made it difficult to conduct ad-hoc meetings at locations other than those initially designated by system installers. WWW technology works across internet protocol (IP) based networks, allowing it to work across a network of networks rather than a single (often local) network.

WWW technology relies on two pieces of software, the server and the browser, which run on different machines and do not have to be run on machines compatible with each other. Both components have now been developed for a wide range of computer platforms including the Intel x86 series CPU, Motorola 68000 series CPU, and a number of RISC machines.

An important feature of the server/browser architecture is that the hyper-text markup-language (HTML) that must be written to define a page is platform independent. Once a browser has been written for a platform, it can be used to read any standard HTML. It therefore is significantly easier for it to be hardware-independent than traditional programming languages such as 'C' or BASIC. Because it is interpreted, not compiled, and because the object code does not have to be distributed to users by the supplier (the users are always reading the latest copy off the suppliers server), it easily manages a multi-platform environment.

The technology for information sharing is organized into pages and stored on a server. Users can use browsers to view the pages, which are written in HTML and is

transferred from the server to the browser, which displays the information on the screen, complete with formatting and multi-media objects.

The language has now been expanded to include user input and calls to other software modules. These features allow a WWW page to become a complete application. Early uses of these features allow people to make queries into search engines by entering a keyword. The system then can return information, such as other WWW pages, containing the keyword.

Later applications became more sophisticated, often containing the features of personal computer (PC) application. This new technology, in many ways, has become the platform of choice for communication/ decision making software and is attracting many new entrants into the field.

The WWW technology and the start up companies that use it could possibly offer a better product at a drastically lower cost than the company was currently producing. Early examples of this threat were still producing software with inferior capabilities, but new product introductions were occurring at an increasing rate.

5.2 The Reengineering Process

An overview of the reengineering process used is presented in Figure 5.1. The quadrilateral objects represent the major steps in the process. The ovals and stars represent major pieces of information that were used in each step in addition to the information that was provided by the previous step. Vision refinement and planning

were addressed throughout the process and were informed and updated by what was learned in each step.

Vision establishment was conducted by management and the board of directors primarily before the study was conducted. It was this vision establishment that highlighted the need for significant process improvement. The planning phase established this project. The “as-is” model development step was used to understand and document the current process. Two “as-is” models were developed, the conceptual model and the empirical model. Finally a single “to-be” model was developed.

As noted in the previous chapter, it was important to have the study take place within the context of a real reengineering effort and therefore the activities that were conducted followed the recommendations of Daniels (1991) (see Figure 2.7). The project also used the tool concepts suggested by Daniels (see Figure 2.8). However, the actual tools used were drawn from more recently developed technologies. Greater emphasis was placed on the use of distributed tools than in Daniel’s work. The study was to be completed at the recommendation stage and not encompass implementation and evaluation, although the organization’s intention to proceed with improvements was seen as important to the study.

Figure 5.1 Reengineering Process

An important aspect of reengineering, particularly in the software industry, is that the effort must be carried out in a short period of time. Taking an extended amount of time for the analysis phase can lead to recommendations that come too late or are no longer valid. However, experts warn that reengineering takes time and cite giving up before the reengineering is complete as one of the reasons for failure. We therefore felt compelled to do all that we could to expedite the study.

In order to reduce cycle-time we enlisted the help of process simulation experts from Delft University of Science and Technology, The Netherlands. They were invaluable as collaborators in the design of the reengineering process and in simulation coding. Working with experts located at such a distance posed certain logistical problems, but the benefit of their specialized techniques was deemed important enough to warrant this cost. The research leader was based in Tucson, in close proximity to the organization, and had a working knowledge of simulation that permitted local changes to the software to be made.

A number of people were involved in the project. The central team consisted of the Tucson research leader, the Delft research coordinator and the local project coordinator. In addition, the management team, the process participants, and a simulation expert were involved in the project. The central team planned the process and conducted a number of events. The management team included the CEO. The process participants included both the headquarters group and a distributed sales force.

The management of the project was highly distributed. Major and minor communication paths are shown in Figure 5.2. This model is an approximation

developed by the research leader and therefore may be biased. Evidence related to the validity of such a model exists in some of the participants' behaviors, a number of whom requested that the research leader forward or request information to or from the research coordinator or the simulation expert. It should be noted that most of the individuals' titles included in Figure 5.2 and used throughout this document were defined after the process and correspond, roughly, to the roles played by the corresponding individuals. No *a priori* designation of roles was made, though task ownership was often identified in planning meetings. However, the CEO, vice president of sales and management team titles had been defined previously by the organization.

An overview of major events that occurred during the project is presented in Table 5.1. The last column of the table indicates which type of reengineering activity, according to Daniels's taxonomy (see Figure 2.7), was being undertaken. In some cases more than one activity was included. The primary activity is shown in bold. It should be noted that many of the types of activities occurred on different scales throughout the process. For example, in any single meeting there were related preparation and vision establishment activities. The table refers only to activities as they occurred at the scale of the project. The dates in the table refer to the dates when the event was the primary focus, but, in many cases, aspects of the task were underway in parallel.

5.3 Planning and Vision Establishment

The preparation and vision establishment phase began on January 25, 1996 with the project kick-off meeting, as shown in Table 5.1. The CEO, the research leader, the

research coordinator and other research advisors met to discuss the need for research in the area of creating insight into new business process designs. The company was agreed to be an applicable target because of its strategic need for reengineering.

Figure 5.2 Reengineering Participants' Communication

The group discussed how GSS and animated simulation would benefit the process. The current set of GSS products were available, along with Arena, an animated simulation development package available from Software Development Corporation

and Lotus Notes was considered as tools that could benefit the process. A complete list of group and multi-user tools available to the project is shown in Table 5.2. In addition to GSS tools, a number of single user tools were available, as shown in Table 5.3. The group decided that the project should begin immediately and planned on making recommendations by summer.

Event	Date	Daniels's Type¹
1. Project Kick-Off	1/25/96	2,1
2. CEO Project Announcement	1/29/96	2
3. Scoping Meeting	1/30/96	1,2
4. Develop Conceptual Model v1.0	1/30/96 - 2/7/96	3
5. Conceptual Model Review Meeting 1	2/8/96	3,4
6. Develop Conceptual Model v2.0	2/8/96 - 2/28/96	3
7. Conceptual Model Review Meeting 2	2/29/96	4,3
8. Strategy Review Meeting	2/29/96	2
9. Develop Empirical Model v1.0	2/29/96 - 3/13/96	3,4
10. Management Review	3/14/96	3,4
11. Develop Empirical Model v1.1	3/14/96 - 3/27/96	3
12. Empirical Model Review Meeting	3/28/96	4,3
13. Develop Empirical Model v2.0	3/28/96 - 5/15/96	3
14. Develop Automation Model v1.0	5/15/96 - 6/1/96	4
15. Develop Preliminary Recommendation	4/15/96 - 6/1/96	5
16. Automation Model Review Meeting	6/6/96	4
17. Present Final Report	7/19/96	5

¹bold indicates primary type, others are secondary

Table 5.1 Overview of Project Including Daniels's Types

After the group identified simulation programming as a likely bottleneck in the process, the research coordinator suggested the addition of a simulation expert to reduce this project risk. The research coordinator took the lead in selecting and attaining the support of a simulation expert.

GSS Tool	Company
GroupSystems for Windows	Ventana Corp.
TeamGraphics	Ventana Corp.
Modeler	Ventana Corp.
Notes	Lotus Development Corp.
E-mail	(various)

Table 5.2 Group Products Used for the Project

GSS Tool	Company
Arena	Systems Modeling Corp.
Word for Windows	Microsoft Corp.
Excel	Microsoft Corp.
CloseUp	Norton-Lambert Corp.

Table 5.3 Single-User Products Used for the Project

On January 29, the CEO announced the project to the organization at its staff meeting and indicated who outside the company would be involved with the project. Many of the staff affected were in attendance.

On the following day the CEO met with the research leader, the research coordinator, the project coordinator, and one member of the board of directors for about an hour to decide on the scope of the project. They concluded that the sales process constituted a significant core process with opportunity for improvement. They also considered the customer support process and decided that a decision to include sales support could be made later in the project.

An important milestone was identified as March 25, 1996, the opening day of a week-long software users' conference, an annual meeting of users of company's

products. Approximately 300 people attend to share experiences and techniques for using the products. It was considered important to the reengineering effort because the distributed sales force would be in one city for the conference, creating an opportunity to increase their involvement in the project. An interim goal was set: to have the first version of the empirical model developed by the conference.

The conference also was expected to have an impact in that customers were being asked to comment on potential new products, thereby providing input to the company's product strategy. The impact of the WWW, as noted above, had been identified internally, but the company needed information on how their customer base was responding to this potential paradigm shift.

The aggressive time-frame thus imposed prompted the team to identify opportunities to reduce cycle time of the reengineering project, particularly by identifying where work could be done in parallel. It was decided that after the construction of a first draft of a conceptual model, coding on the empirical model could be completed.

5.4 Conceptual Model Development

Two conceptual models, a process model and an activity model, were developed by the research leader using TeamGraphics group drawing software for the process model and Modeler for the activity model. The process model was started first, followed by the activity model after the process model began to stabilize. The process model is shown in Appendix A.

While TeamGraphics allowed for drawing the process model, it had no support for capturing the related data. For this purpose we used Modeler, an activity modeling tool generally used by groups to develop activity decomposition models of business processes. In our case, the model was significantly developed before we were able to schedule a broad user meeting so the model was developed by the research leader as an abstraction of the process model developed using TeamGraphics. All the activities in the process model were reproduced as leaf nodes in the activity decomposition. The higher level nodes were given arbitrary names by the analyst and were used to group closely related activities.

5.4.1 Conceptual Model v1.0

The research leader and the research coordinator spent the balance of January 30 with headquarters processes experts (HQPEs) to sketch the first draft of the conceptual model. The chosen technology for the day's activities was the use of large sheets of paper and pencils. The electronic tools were still inconvenient for first draft sketching..

HQPE1 was a person who had been involved in a previous effort to identify systems needed to support the organization, particularly the sales process. The effort involved a self-organized team that began to document the process and assess technology that could be used to improve it. Although management had not followed their recommendations, their effort provided processes documentation that proved to be an important starting point in the development of the conceptual model. HQPE1 met

with us for about an hour to describe the process as she understood it and provided us with jump-start to our work.

We then spent the remainder of the day interviewing others regarding our conceptual model, finding a significant lack of detail when we interviewed someone who worked in areas of the process not yet modeled but very few contradictions of previously mapped processes.

Over the next week the process model was drawn in TeamGraphics, largely as it had been sketched on January 30. A few interviews were conducted with process experts within the company for clarification and then the activity model was drawn. The activity model provides a hierarchical decomposition of the activities in the process. The Modeler tool was use for this purpose because of it ability to work with groups and its customizable data fields.

In some cases, activity models can be used for process analysis and redesign, but in this project, it was used as a project dictionary and communication tool while the process model was used for analytical purposes. These choices were made on the basis of the conceptual capabilities of the modeling metaphors as well as tool capabilities as instantiated. Because we intended to analyze the process flow, the process model was an appropriate metaphor. The available process diagramming tool, TeamGraphics, provided group support, but did not provide the capability for recording process data. Alternatively, the Modeler provided more robust group support plus the needed data fields associated with each activity. Also, the Modeler provided for the inclusion of additional data fields to be defined by the user. This first version of the model was

completed on February 7 and will be referred to as conceptual model v1.0. The high-level process diagram of the sales process is shown in Figure 5.3. The complete model is shown in Appendix A.

On February 8 a model review meeting was held to review conceptual model v1.0 with the process experts. The review meeting began a little after its scheduled start time of 10:00am and was attended by seven process experts, with the research leader acting as facilitator. Employees representing all aspects of the process under

Figure 5.3 High Level Sales Process Model

consideration except prospect enhancement, which is largely carried out by area managers who are distributed across the country, were present. The meeting was scheduled for one hour, but lasted an hour and a half.

The review began with a presentation of the activity model. The graphical hierarchy view of Modeler was used to walk through the process. The rationale for the project and its scope were presented. Since the model hierarchy had been built by the research leader as an abstraction of the process model, the names used were not familiar

to the group. This led to a more detailed explanation of the hierarchy structure, with some of the names changed at the request of the process experts. The group appeared skeptical that the exercise of developing models would be useful to them. During the overview the group questioned the scope of the project.

At 10:40, the group began to validate the sequence of tasks. The sequence review used a process model similar the one shown in Appendix A¹. Handouts were give to all participant and the facilitator guided the group in a walk-through. As the group noted errors, they described them to the facilitator who took notes on a copy of the model.

During the review, one participant remarked that that the model did not capture the way she worked though she did not know specifically what should be changed. The facilitator asked her what was different about the way she worked. She described how she did a lot of things not captured on the model and the sequence of the tasks she did was different everyday. She expressed doubt that a model could be drawn that would adequately describe what she did. The facilitator said that some of the tasks she was describing were not sown because they were considered outside the scope of the model. The facilitator also explained that the model did not show the sequences of tasks any individual performed. It was intended to show the sequence of steps and entity, such as a purchase order, would follow as it is processed by the organization. Other participants

¹ The actual process model used was an early version of the one shown in Appendix A.

offered explanations of the what was being modeled as well. She indicated that she understood and that we could move on, but appeared to have doubts.

Another difficulty in reviewing the model was in backtracking to branches of the process that had been temporarily bypassed. The group would focus on one branch of a process at a time and have to return to the branch point to follow another branch. This review algorithm was similar to a depth first search of a tree data structure. However, humans, unlike computers, have a difficult time remembering where they left off which made it difficult to review processes with many branches. Particularly this was a hindrance when it was important to understand what activities were being undertaken at the same time such as the development of an invoice and packaging of a product. In this process, invoices can be started as soon as a decision has been made to honor a purchase order, but they cannot be mailed until confirmation that the order has been shipped is received.

Table 5.4 summarizes the changes that were made to the model as a result of the 2/8/96 model review meeting. Additions represented new tasks added to the model. Deletions represented tasks removed from the model. Modifications represented changes to the description of the task or significant changes to the timing of the task relative to other tasks. The number of initial task shows that the model did not receive a balanced decomposition. The choice of break points was made based on traditional phases of the sales cycle. Also, A2.2, Prospect Enhancement, was expected to grow substantially after further interviews with area managers. A2.3, Proposal Development, is done by one person and since no one else at the meeting had significant knowledge of

the process it received no changes. A2.4, Order Processing, involves a number of people, each of whom has developed ad-hoc methods of balancing work load and handling exceptional situations and therefore this section of the model changed substantially.

Sub-Process	Initial Tasks	Add	Delete	Modify	Final Tasks
A2.1 Receive and Process Prospect Inquiry	12	4	0	2	16
A2.2 Prospect Enhancement	19	3	0	0	22
A2.3 Proposal Development	13	0	0	0	13
A2.4 Order Processing	59	26	4	20	81

Table 5.4 Changes to Process Model v1.0 Due to 2/8/96 Model Review

Ten of the additions to A2.4 came from an expansion of scope of the modeling effort to include renewal processing. Renewals of the software licensing agreement entitle the user to software upgrades and technical support, and renewal letters are sent to customers before their licenses expire as reminders that it is time to extend the license. Although, this process took a considerable amount of the time of one of the people attending the meeting, it appeared from the discussion that it would require almost no labor if the sales process were to be fully automated. Therefore, this task was added to the project.

The modifications were primarily detail oriented. For example, the number of copies made as a part of some of the tasks was changed. Four tasks were modified by changing their sequence.

One important change to the model came in the area of packaging and shipping, where changes had been made between 1/30/96 and 2/8/96. Disk branding was moved from the technical support department to the customer support department. The resulting improvement is shown in Figure 5.4, an abbreviated process model of packaging and shipping. Two physical delivery steps that were eliminated were expected to reduce cycle time and labor time as well as complexity of the task.

After the hierarchical model was used to describe the scope of the project, the process model was analyzed in more detail, primarily for the purpose of validation.

5.4.2 Conceptual Model v2.0

Conceptual model version 2.0 was developed using the feedback given at the conceptual model version 1.0 review meeting as well as from further interviews. The review meeting was also the beginning of data collection and development of the empirical model. See the next subsection for more detail on the development of the empirical model.

5.5 Empirical Model Development

Empirical model development and data collection began following the conceptual model v1.0 review meeting. This meeting provided a strong process model for the simulation experts to begin coding. It also introduced the group to the activity conceptual model which was used in distributed mode to collect expert analysis of the activities and begin data collection for the empirical model. Empirical model v1.0 was

developed from the structures defined in the conceptual model with model parameters estimated. Empirical model v2.0 was developed with the structural refinements in conceptual model v2.0 and the data collected on parameters.

5.5.1 Simulation and Animation Coding

The empirical model was developed by the simulation expert and the research leader after the conceptual model was subjected to initial face validity tests. Continued expansion in depth and detail of the conceptual model continued through most of the study and the results were propagated to the empirical model. An animated view of the empirical model is shown in Figures 5.5 through 5.11. Unfortunately, the dynamics of the models are difficult to convey in the static medium of a manuscript. Each of the views represents only a snapshot of the animation. The simulation code that drives the animation is shown in Appendix B.

The empirical model was developed using Arena software created by Systems Modeling Corporation. The software allows for simultaneous development of simulation and animation and is an outgrowth of the company's early work on Simon and Cinema, a simulation and animation software pair. The Arena software operates in edit and run modes. The run mode is shown in Figure 5.5 and the edit mode of the same view is shown in Figure 5.6. The edit mode displays a number of tool bars with functions needed for design models while the run mode eliminates most of the distractions for easy viewing of the model. Both modes have options for customizing the tool bars available.

Layouts and color schemes were consistently maintained across the views of the animation to facilitate group presentations. The presentations were modified throughout the project to enhance participants' viewing of the models.

The first version of the model used a color scheme similar to that used by the actual organization. These colors looked appealing when viewed on a computer monitor by a small group of people, but were difficult to see when viewed on a projector by larger groups. The color scheme was then changed to that used by executives in the organization for their own presentations. The building and data screen backgrounds were blue. The headings were yellow and other words were white.

The first version also contained too much detailed information. This information was useful to the analyst, but was distracting for people viewing a presentation. Later models separated data analysis and process flow views. Figures 5.5 through 5.9 show process flow views that can be used in presentation environments. Figures 5.10 and 5.11 show data analysis views that can be used by an analyst or a small group. Although, these views have too much information to display to a large group, combination of a number of related statistics into a single view can be useful to the analyst who wants to compare values at given points in time.

Figure 5.5 shows a screen capture of the animated view of the Tucson headquarters of the organization. The building layout, while captured at a high level of abstraction, retains the basic spatial relations found in the work place.

Figure 5.5 Headquarters View of Animation (run mode)

Figure 5.6 also shows the headquarters view of the animation, however, the animation software is shown in edit mode which is used by the systems analyst to develop the model. The tool bars shown are optional. The scale of the image is set by the analyst.

Figure 5.6 Headquarters View of Animation (edit mode)

Figure 5.7 shows a view of the Washington sales office of the organization. In this view the work of the sales development coordinator (SDC) is depicted. Above the SDC are icons representing an ACT! database with customer inquiry information. The number in the left database icon represents the number of follow-ups that needed to be made by the SDC at a future date. The number in the right icon represents the total number of inquiries logged to the database. The rectangular icon to the right of the U.S. mail represents an information packet being sent to a prospect.

Figure 5.7 Washington Sales Office View of Animation

Figure 5.8 shows the “outside world,” defined here as including everything outside of the headquarters office and the sales office. The human icon in the upper left corner represents an area manager. In this view, only a single area manager, representing a typical area manger, is shown. The customer area represents all customers. The airplane icon moves between the area manger icon and customer area to depict the area manager’s visit to a customer. Blocks with DC and HQ in the lower left represent the

two offices of the company. They were added late in the process at request of participants in the model review meetings who wanted to know where icons that moved off the screen were going.

Figure 5.8 Outside World View of Animation

Figure 5.9 appeared to give a good high level overview of the area manger process, but seemed to be too abstract to be useful in developing improvement ideas. A more detail view of the area managers was developed and is shown in Figure 5.9. This

view has separate icon for each of the six area managers. It also allows for the display of a wider variety of area manager activities. Figure 5.9 shows area managers engaged in demonstration, prospect response, and other activities. The “Job” icon to the right of the desk of the upper area manager icon shows pending work.

Figure 5.9 Area Manager View of Animation

Figures 5.10 and 5.11 provide an overview of important model statistics for use by the analyst. Figure 5.10 provides validation statistics in the frequency of area manager

meetings, demonstrations and e-mails; the length of the area manager queue; and the quantity of information packages, proposals, and invoices sent by the organization. These statistics can be compared to the expected values to see if the model is reflective of the actual system.

Figure 5.10 Model Validation View of Animation

Figure 5.11 Headquarters View of Animation

5.5.2 Data Collection and Validation

A variety of methods, including time records, document analysis, interviews and expert estimates, were used to collect data for the design and validation of the model. To the extent possible, estimates were made by more than one method.

Time records were forms developed by the lead researcher to allow the process experts to record start and end time for each major activity. Appendix C. shows two

examples of time logs. Figure C.1 shows the time log used for the Sales Support Department. A similar form was used for all departments except reception, which used a custom form designed for that position. Figure C.2 shows the reception time log. The forms were designed to be completed by the users in minimal time. Tasks listed on the form were abstracted to the level of the empirical model, which is less detailed than the conceptual model. User reaction to filling out the forms was largely negative because people perceived them as time consuming and of limited value. One person had used similar forms at a previous job and noted that they took considerable time to complete and had no impact on the improvement effort. After an explanation of the form's use, the negative reaction was mitigated. Except for the reception form, the time logs required only a few entries per day and permitted batch entries. Batch entries are single entries that include a number of occurrences of an activity within a time frame.

The results of the time logs were mixed. Some logs had little information while others were completed well. Collection of the logs did have a positive side effect of providing an opportunity for brief interviews that led to a better understanding of the process on the part of the researcher. All data log data were verified through a follow-up interview used to ascertain the face validity of the data and ensure that the logs were interpreted correctly. In some cases, the logs were interpreted differently than the researcher had expected, but the data was found to be still useful, if the correct interpretation was used.

Document analysis provided some information for the empirical model in the form of completion rates for proposals, purchase orders and demonstration packages.

No documentation of task times was found. Much of the available documentation was filed by customer making it difficult to construct a chronology. Accounting data was used to calculate invoice and purchase order frequency.

A chronological file was kept by customer support to record the distribution of demonstration software packages and other miscellaneous software distributions. Since most demonstrations do not require software to be sent from headquarters, this data could not be used to determine demonstration rates. However, it could be used to determine the impact of demonstrations on the customer support department.

The Modeler was used to collect task descriptions and activity times from the process experts. The Modeler was accessible from the desk tops of all participants in the sales process. As with the time logs, success with this method of data collection was mixed. However, the highest quality data came from a different source than it had in the case of the time logs, making it a complementary data gathering method. Participants were given one week following the conceptual model v1.0 review meeting to complete the information. Interviews were conducted with process participants from all areas of the process.

When conflicting data were obtained, additional data collection was undertaken to resolve the differences. An example of what the research leader had originally interpreted as conflicting data was the rate of demonstrations as reported by the area managers and as determined from the customer support file. The rate as determined by the customer support file was much lower than that determined by interviews with area managers. The process model indicated that area managers requested a set of

demonstration disks every time they scheduled a demonstration. However, in reality, area managers only needed disks a small fraction of the time because they had other means of demonstrating the software such as borrowing facilities where the software was already installed. After this point was clarified with additional interviews, the model's structure and parameters were updated.

Model validation included structural validation undertaken in group review meetings as well as numerical validation from data collected.

Start-up time was significant for the model because nearly all actions were driven by the arrival rate of inquiries. Inquiries moved through the system from initial stage through completion of purchase order with attrition rates at various stages. Therefore, the model required many simulated weeks for initial inquiries to load down the system. The start-up time was determined by observing several rate and level variables to discover the time at which they attained a stable stochastic state as recommended by Wilson and Pritsker (1978) and Meel (1993). A start-up time of 90 simulation days was chosen. Twenty-two day graphs of the number of pending area-manager follow-up calls, proposals per day and purchase orders per day are shown in Figure 5.12. Figure 5.11 show the same variable after 30 days. The graphs show the delay effect between the variables. The number of pending follow-up calls was nearly stable whereas purchase orders were just beginning to arrive. This is due to the delay in customers' making purchase decisions and the delay in customers submitting proposals.

Figure 5.12 Model Stabilization

5.5.3 Empirical Model Review

Two formal model reviews and a number of informal reviews were used to validate the empirical model. These reviews contributed to the correctness of the model as well as the quality of its presentation.

The first formal review was done in conjunction with a management briefing on March 14, 1996. Model review portion of this meeting lasted about an hour.

5.6 Improvement Goals

The goals for the improved system are multidimensional and include improved efficiency, improved quality and improved effectiveness. Additionally, the process should be designed to meet these goals under predicted scenarios of increased product volume and increased breadth of product offerings.

The goals were developed primarily at the strategy meeting on 2/29/96 and were derived from the organizational strategy. These goals were also discussed during subsequent review meetings and interviews and were designed to be quantifiable and measurable to the extent possible. Some of the goals were identified when the reengineering team was asked about problems in the current system. For example, a problem identified by a number of participants was that software is sometimes sent to the wrong address which implied the need for an improvement goal of reducing shipment errors.

In terms of efficiency, the process should be improved to have substantially fewer labor hours incorporated into the production of the product. Efficiency, as measured in revenue per employee shows the organization's efficiency as lower than industry norms. Two- to three-fold increases should be made for routine tasks. A common efficiency measure, cycle time, does not appear to be a significant issue. Currently, most product is shipped within 24 hours of receiving an order, which is expected to be acceptable to the customer. However, it will be important to maintain this cycle time in the future under higher business volumes.

Quality improvements should be made in the areas of reduced mistakes and prompt answers to customer questions. Currently, some customer questions regarding the status of orders or the availability of products require putting the customer on hold or disconnecting from the customer and making a return call.

Improvements in effectiveness are needed in the area of selling more product. Every contact with a customer is an opportunity to make or support a sale. The system can be improved if those who come in contact with customers have information about the customers and information about the status of current product opportunities so opportunities for sales can be exploited.

These goals must be achieved with a system that can handle increasing sales volumes and still perform at improving levels of service to support the organization's strategy.

5.7 Improvement Ideas

It is clear that a computer based information system can make substantial improvements to the process across of the dimensions of improvement identified.

Rathnam, Mahajan and Whinston (1995) show how matching IT to problem resolution processes in a customer support team can reduce coordination gaps that hinder the effectiveness and efficiency of the process. One process factor they cite as increasing coordination gaps is interconnectedness. "Interconnectedness is defined as the nature and extent of the one-to-many mapping between tasks (and their possible states or phases) and roles." In the sales process, the one-to-many relationship between

the order processing task and the many departments called upon to fulfill that task implies a high degree of interconnectedness.

5.7.1 Automation

In nearly all meetings with subject matter experts, recommendations for automation appeared. Recommendations for automation also were made by outsiders who viewed the animation. It has become clear that an automated system would offer significant benefits to the organization. However, it is not clear to what extent and in what way reorganization should accompany such automation. As a first step in approaching this problem, simulation experiments were run on the proposed automation system.

The automation version of the simulation received no structural changes. It received parameter changes to the task times affected by an information system. To facilitate the execution of the treatments, effected parameters contained boolean parameters so that both automation times and non-automation time could be programmed in the same simulation, and switched between experiments. The variable “automation” was set to 1 to select automation values and to 0 to select non-automation values. For example, the formula used for time to package a product is shown as Formula 1.

Formula 1: $\text{tria}(45,50,60) * (\text{automation} = 0) + \text{tria}(20,25,40) * (\text{automation} = 1)$

Daft and Lengel (1986) suggested that an organization’s information systems should match its organizational processing requirements. Particularly in the case of

interdepartmental information systems, it is important to consider the relationship between the departments in terms of difference and interdependence. Difference is determined by the differences in special training or professional socialization. Interdependence is determined by the amount of effect a change in one department would have on another.

DIFFERENCE BETWEEN DEPARTMENTS	High	<p>High Difference, Low Interdependence</p> <p><u>Structure:</u></p> <ul style="list-style-type: none"> a. Rich media to resolve differences b. Small amount of information <p><u>Example:</u> Occasional face-to-face or telephone meetings, personal memos, planning, self contained units.</p>	<p>High Difference, High Interdependence</p> <p><u>Structure:</u></p> <ul style="list-style-type: none"> a. Rich media to resolve differences b. Large amount of information to handle interdependence <p><u>Examples:</u> Full time integrators, task forces, teams, matrix structure, special studies and projects, confrontation.</p>
	Low	<p>Low Difference, Low Interdependence</p> <p><u>Structure:</u></p> <ul style="list-style-type: none"> a. Media of lower richness b. Small amount of information <p><u>Examples:</u> Rules, standard operating procedures, reports, budgets.</p>	<p>Low Difference, High Interdependence</p> <p><u>Structure:</u></p> <ul style="list-style-type: none"> a. Media of lower richness b. Large amount of information to handle interdependence <p><u>Examples:</u> Plans, reports, update databases, formal information systems, pert charts, budgets, schedules.</p>
		Low	High
INTERDEPENDENCE BETWEEN DEPARTMENTS			

Figure 5.13 Relationship between Inter-department Characteristics and Information Processing Requirements (Daft and Lengel 1986)

The headquarters departments associated with the sales process can be characterized by low difference and high interdependence. The information processing requirements for departments with this type of relationship comprise large amounts of low richness data. One example of this type of relationship is a formal information system, suggesting that the addition of a shared computer based information system would benefit this organization.

5.7.2 Proposed Reorganization

The automation recommendation supported by the work of Daft and Lengel (1986) is based on an assumption that the departments remain organized as they currently are and the finding that the departments show small differences and are highly interdependent may suggest that departments should be combined.

Huber and McDaniel (1986) described the importance of the decision-making paradigm for organizational design. They agreed with Simon's arguments that decision making is "the central activity in which the organization is engaged" (Simon 1973, p. 270). "The implied organizational effectiveness criterion is maximization of the quality (broadly defined, e.g., including timeliness) of organizational decisions" (Huber and McDaniel 1986, p. 576). In terms of the sales process, the job of the headquarters staff can be framed as one that focuses on decision making. Responses to questions from customers are essentially decisions based on the problems posed by the customers' questions. Writing proposals and processing purchase orders primarily involves deciding what the customer wants and how to fulfill the request.

The emphasis on the decision-making paradigm becomes even more significant if one considers improving the system beyond what can be done through automation. Automation eliminates much of the need for maintaining paper filing systems, physical routing of paper work and custom development of correspondents. Each of these activities can be seen as requiring craft-like skills that were important to quality in the “as-is” model. These skills are no longer relevant in the automation system. What has become relevant is entering the correct new data, selecting the correct options for meeting a customer’s requirement and searching and effectively using the information and communication systems.

In addition to other changes brought on by adoption of new information systems, a reengineered organization potentially will require decision-making regarding the process. It is unlikely that either new information system or the new organization will be designed optimally in a single *a priori* effort. A prototyping approach in which participants evaluate changes and suggest improvements will probably be required during implementation and potentially for the life of the system. The quality of the system will therefore benefit from a design that facilitates decision-making to further improve it.

Cohen, March and Olsen (1972) described the garbage can model of organizational decision making. Their work suggests that a good deal of randomness is involved in the process. The metaphor of the garbage can suggests that problems and solutions are mixed together in a large container so that when a problem and a corresponding solution are observed in close juxtaposition, individuals can put them

together to effect a solution. It appears appropriate, then, to put tasks of a process that may have problems together with other tasks of the same process that may provide ideas for solutions.

5.8 Reorganization Design Meeting

On June 6, 1996, a reorganization design meeting was held to create design proposals for a new sales process. Previous meetings that had developed improvement ideas usually focused on automation and minor process changes. The goal of this meeting was to allow the participants to redesign a new process without regard for the current system.

A professional ethnographer was asked to document the process to help the researchers understand the process as it unfolded. The lead researcher designed and facilitated the meeting, assigning the ethnographer the role of third party observer to validate the results. To control for confirmation bias, the ethnographer interviewed the facilitator prior to the meeting.

5.8.1 The Meeting Plan

The meeting agenda is shown in Figure 5.14. The meeting was designed to begin with divergent thinking and to leave convergence to the design teams. The first three exercises, all of which used the GroupSystems categorizer tool, were divergent. The first exercise included a review of the animation model of the process and a discussion

about problems existing in the current system. This model had been seen earlier by some members of the group and was new to others.

Agenda Reengineering Design Meeting Sales Process	
10:00	Review Animation Discuss Problems with As-Is (CA)
10:20	Describe Automation Simulation Results What other benefits to automation are there? (CA) What are the problems with automation? (CA) How can the process be improved beyond what can be done with automation? (CA)
11:00	Describe suggestions for reorganizing What are the benefits of the suggested reorganization? (CA) What are potential problems with the suggested reorganization? (CA) What are some better ways to reorganize? (CA)
11:45	Assign design teams
12:00	Lunch
1:00	Teams redesign process
1:30	Teams present ideas
2:00	Critique proposals
2:30	Vote on proposals

Figure 5.14 Reengineering Design Meeting Agenda

The second exercise was a high level review of the benefits of automation of the system. Process improvement times were derived from simulation experiments. Annual multipliers were derived from accounting records. The purpose of this exercise was to

discuss the benefits of automation so that ensuing discussions could focus on benefits that might be derived beyond those provided by automation. The electronic discussion was also used to generate ideas on other aspects of the process in addition to the four presented in Figure 5.15 that should be evaluated in relation to automation.

Activity	"As-Is"	Auto	Savings	Per Year
Proposal	1.6	0.8	0.8	110.4
PO	2.6	1.4	1.2	228
Renewal Let	0.5	0.2	0.3	120
Misc. Inv.	0.5	0.2	0.3	180
Total				638.4
Work Overhead			1.14	729.6
Overheaded Labor Cost			40	\$29,184

Figure 5.15 Automation Benefits (as presented)

The third step of the idea generation phase of the meeting was designed to encourage the participants to think of broad organizational changes that could improve the process. For this purpose a dramatic organizational change was presented. The slides shown in Figure 5.16 were used to illustrate a change from the "as-is" to the "to-be". The "to-be" reorganization model in Figure 5.16 was shown to the group as two overlays. The first overlay contained only the three main boxes representing departments without the word "out-source" or the "X" across the materials/shipping department. Although the second overlay would be shown displaying the "X", prior to its display, a number of participants suggested that the materials/shipping department

could be out-sourced and the project coordinator already had begun to investigate the possibility. Figure 5.17 shows the slide that was used to show the design philosophy used to generate the “to-be” model.

The second phase of the meeting was designed to allow the group to take the earlier discussions and examples and synthesize them into a new design.

5.8.2 The Meeting

The meeting started at about 10:10 with 10 participants. The facilitator opened the meeting with an overview of the meeting agenda and the purpose of the meeting. The first step was a brief animation walk-through, followed by a discussion of the problems of the current process. The discussion considered some of the high level problems with the system that were consistent with problem discussed in previous meetings.

The second step began with a presentation of the benefits of automation, during which the participants asked for more information on the assumptions used to derive the improvements estimates. One person noted that the number of miscellaneous invoices per year might be higher than the number stated. Further scrutiny of the data was deferred. The estimate of \$40/hour for fully overheaded average wage rate was questioned. The number was explained and, though the group was not completely convinced it was valid, no alternative was proposed.

Figure 5.16 Reorganization Example Slides

Design Strategy

- Facilitate Continuous Improvement
- Reduce Points of Contact
- Reduce Steps in Processes
- Combine Like Processes
 - On-Demand Information Work
 - Cyclical Information Work
 - Materials and Shipping

Figure 5.17 Design Strategy Slide

The first discussion during the second step, “What are the benefits of automation?” had the heaviest participation of the three. One comment referred to skepticism about the data presented regarding the benefits of automation. Other comments referred to the general benefits of automation including time savings, capacity increase and improved data accuracy. A few of the comments suggested an obvious need for automation and that the point for discussion should be how to automate rather than why to automate.

In the second discussion, “What are the problems with automation?”, two main issues arose. The first was a fear that an automated system would make customers feel

they were being treated in an impersonal manner. The other was a fear that an automated system would not handle exceptional situations well.

In the third discussion, "How can the process be improved beyond automation?", the group entered two ideas. The first stressed the importance of defining areas of responsibility so that customer would not be transferred more than necessary and other involved recognizing the need to provide area managers with guidelines on the information they should submit to HQ with proposal requests.

In the third step of idea generation phase, an example of a possible reorganization was presented. Several members of the group questioned the meaning of the block diagram. They were not sure whether the blocks represented new departments or just related activities. After some discussion, it became clear that the blocks were intended to represent new departments. Many in the group saw aspects of the example that might have value.

In the first discussion, "Benefits of the suggested reorganization," only one benefit was cited: that the proposed system would have only one point of contact for many customers' questions. However, two small debates occurred. In one it was argued that the presentation was confusing because the names of the departments corresponded to names in the current system. The other debate concerned the propriety of having a wide range of personnel privy to invoice information.

In the verbal discussion that occurred in parallel with the electronic discussion, some in the group suggested that we were wasting our time talking about reorganization when the automation system had not yet been installed. They suggested that it would be

better to take one step at a time by first installing the automation system and assessing how it went. Discussion of reorganization could follow. Some argued that discussion of reorganization could slow accomplishment of the goal of automation. Others argued that a reorganization plan would give a vision of where the company was headed and could guide implementation of the automation system.

Similar discussions emerged in the second electronic discussion, "How to..."² Additionally, the participants discussed the need for cross training if the reorganization example were to be implemented. The third electronic discussion, "better ways to reorganize" included discussion of automation.

In the second phase of the meeting, the participants were divided into two cross-functional teams. The teams went into their own conference rooms and were asked to develop reorganization ideas. Lunch and printed copies of the previous discussions were given to all participants while They talked informally and sketched their ideas on flip charts.

Following small groups design meetings, the full group reconvened and each small group presented its redesign ideas. The groups developed similar proposals so the facilitator suggested capturing the commonalties on the copy board. The result of the

² The phrase "How to..." was used in place of the questions on the agenda which began with "What are the problems with" because it was considered a more positive way of asking the question by the members of the organization. Though the phrase may not be clear to outsiders, it was in common use within the organization. This phrase was substituted at the time of the meeting.

facilitated summarization is shown in Figure 5.18. The figure describes what functions what functions should be included in a newly organized customer support department and which should be outside the scope of that department.

A number of similarities and differences can be identified between the model described by Figure 5.18 and the “to-be” reorganization model shown in figure 5.16. Both models suggest the consolidation of purchase order processing and invoicing as well as the data entry portion of proposal development. This consolidation would result in a less fragmented order processing system than the one currently in place. Both models suggest outsourcing the materials/shipping department. All meeting participants verbally concurred that outsourcing this department would be desirable.

Figure 5.18 Summary Copy Board Output

The two models suggest different way of organizing renewal processing and writing proposals.. Figure 5.18 suggests that renewal processing belonged in the “to-be customer support department and Figure 5.16 suggests that it belonged to the administration department. Figure 5.18 suggests that writing proposals is outside the scope of the customer support department while Figure 5.16 suggests that it belongs in that department.

5.8.3 Meeting Reflection

Reflecting on the meeting activities, the project coordinator suggested that a lack of knowledge on how to reengineer may be a hindrance to the team design activities. Most of the participants were not sure what principles they should draw upon to modify the processes. The slides shown in Figure 5.16 and 5.17 were designed for this purpose, but participants asked for more information.

The project coordinator noted that the design of the meeting may have been too complex and should have moved at a slower pace. The participants were new to the process of reengineering and had a number of questions about the process, reducing the amount of time spent on particular content. The participants felt they could not afford to commit more time than was allocated for the meeting and therefore time was not extended for meeting tasks.

The peak in positive energy about the redesign as depicted in Figure 5.18 occurred about 15 to 30 minutes before the conclusion of the meeting. The enthusiasm

faded as the group began to explore the details the reorganization implied which resurface questions as to whether or not changing would be worth the effort.

5.9 Chapter Summary

This chapter has described the reengineering process used in this study. The process began directly after the executive management team completed its strategic plan. The process was completed with recommendations to the president. The major tasks included in the process were development of conceptual empirical models of the “as-is” process, development of an empirical model of the proposed automation systems, and development and evaluation of proposals for reorganization.

Figure 5.19 shows an overview of the timeline for the project. Planning for the project took place throughout the project. An initial plan was made, but it was updated as more data on how to best address the problem were found. Toward the end of the project, planning began to focus on what should be done next. Conceptual model and empirical model development had significant overlap in time. This was done by design to reduce cycle time. Parts of the conceptual model that were considered close to valid were given to the empirical model developers while other parts were still under construction. Participants in the process began developing improvement ideas from the beginning. Most meetings were planned in ways that allowed improvement ideas to be captured as they came up, but concentrated efforts to refine those ideas was postponed until the end of the process.

Figure 5.19 Overview of Timeline

The crucial effort of the process was the reengineering design meeting in which the participants developed ideas for reengineering the organization. The group did not fully reach consensus on what should be done, but they agreed on some aspects.

CHAPTER 6 RESULTS AND REVISED THEORETICAL MODELS

The propositions of the study appear to be supported, however some caveats are noted. Proposition 1, focus theory is a useful theory for applying technology to novel problem domains, was found to be useful, but not complete. A fuller consideration of vested interest and the effect of time was needed in the context of group projects in the organizational setting. Proposition 2, GSS and animated simulation can help reengineering project teams create “to-be” models, was also supported, however, the way in which the tools are used has an impact on team effectiveness and it is likely that improvements to the tools will increase their usefulness.

The research question, how can GSS and animated simulation be used to help groups create “to-be” business process models, was answered. The reorganization design meeting documented in Section 5.8 demonstrates one way in which the tools can be used effectively. Difficulties in the meeting suggest where further improvements can be made. Although future work will likely uncover better processes, particularly as improved tools become available, this research demonstrates that the use of these tools is effective and worthy of continued investigation.

Section 6.1, Focus Theory, elaborates on the findings regarding proposition 1 and suggests how focus theory can be enhanced for greater explanatory power. Section 6.2, The Value of GSS and Animated Simulation, describes the benefits and limitations experienced using the tools in this study. Section 6.3 summarizes the chapter.

6.1 Focus Theory

Focus theory was useful in designing tool support for the reengineering effort, although its focus on only goal achievement appears to be a limitation. The goal congruence construct does not appear to be enough to explain the cognitive effort applied to the task. It appears that process accord, a belief that the process being used is likely to achieve its goal, is just as important. Together with goal congruence, these constructs make up vested interest. Further, the consequences of group problem solving efforts not only involve achievement of objective goals but also a change in the character of the group itself. Therefore it is suggested that the productivity construct impacts on vested interest. Additionally, productive meetings create information and some of the information is learned by the participants. Whether that information is content or process related, it is likely to improve their performance in the future and therefore productivity may have a direct impact on cognitive effort. A revised version of focus theory is offered in Figure 6.1.

6.1.1 Vested Interest

The goal congruence construct as presented in focus theory appears in need of enhancement given the complex social and political environment in which reengineering exercises are conducted. Organization members are often skeptical of process improvement efforts because they either have been involved directly or have heard about process improvement efforts that have had no results. In conducting this study, it appeared that some participants wanted to improve the process but did not

believe that project would yield any results. These participants put some effort into the project, but it is unlikely that they put in as much effort as they would have had they had a strong belief that it would be effective. We define this belief in the process as process accord.

Figure 6.1 Enhanced Constructs of Focus Theory

This is not to suggest that goal congruence is any less important than described by focus theory. Participants in this study expressed concern about what affect the changes would have on them. In fact, when individuals commented that the process being used for reengineering would not work, it was not clear whether they thought the process really would not work or they were trying to hinder the process because they did

not believe in its goals. However, it was apparent that they were trying to dissuade enthusiastic participation of others by arguing that the goals are too difficult to achieve.

It is suggested that both goal congruence and process accord motivate the cognitive effort as described by focus theory. The two constructs appear to be distinct and critical. The two way positive influence arrows between the constructs are used to indicate that there appears to be interaction effects between them. In other words, it appears that people need a belief in both the goals of the process and the ability of the process to reach those goals to expend full effort. The importance for researchers and practitioners is that specific and distinct actions need to be undertaken to effect the constructs.

The importance of identifying the process accord constraint is that different interventions are likely to bolster it than those that are likely to affect goal congruence. For example, expounding on the benefits of reengineering may improve goal congruence without convincing a group that results are achievable.

In the case presented in Chapter 5 an attempt was made to increase process accord by explaining action plans and the link the plans, their deliverables and goal achievement. In individual meetings, this approach was generally effective. By explaining an agenda and how the steps on the agenda would lead to the meeting goals, participants were generally convinced that the goals could be achieved. This of course did little to encourage participants that disagreed with meeting goals.

At the level of the project, process accord was more difficult to achieve. The project plan was at a higher level of abstraction than a meeting agenda and relied on a

number of contingencies which made it more difficult to make clear links between planned actions and expected outcomes. One of the unclear aspects of the plan was the pending change of the company's president. It was not clear how the new president would respond to recommendations made by the reengineering team.

Of course, goal congruence was also a factor in motivating cognitive effort. It was clear from the reengineering team that participants held a wide variety of opinions on the value of reengineering and its potential outcomes.

6.1.2 Information Access

The information access construct of focus theory is supported as being significant to the process, however, it appears to require different efforts to affect that communication and deliberation. The standard tools of GSS appear to improve both communication and deliberation in many domains as long as they are configured properly. Information access requires not only proper configuration of the tools, but also the proper selection and timing of content.

In this study we focused on providing participants with business process information in a way that required minimal cognitive effort to understand and this appeared to benefit the process. However, there were indications that reengineering process information may also have benefited the group. More information increases the difficulty of its assimilation so the optimal amount information is unclear.

Throughout the reengineering project, no organizational improvement ideas, other than the one shown in Figure 5.3, were generated, although incremental change

suggestions were offered throughout the process. However, after being presented with a hypothetical example of a reorganization, the group incorporated some of the examples ideas and some of their own into new organizational design ideas. This demonstrates that although the animation appeared to reduce the cognitive load of understanding the process, additional information was required to inspire organizational design ideas.

6.2 The Value of GSS and Animated Simulation

6.2.1 The Value of GSS for Reengineering

More and more detailed process information was gathered using GSS methods. The prospect enhancement process is carried out by personnel primarily outside the Tucson office and therefore the process modeling was started by using telephone interviews. Straw models were faxed to the interviewees prior to the interview. The amount of detailed information obtained was limited. Later, the personnel involved in the process were brought together in Tucson for a model review meeting. In this meeting the participants critique the model in a GSS tool. The participants provided more model information in this meeting than in the previous interviews. It appeared that the face-to-face explanation of the purpose and process helped them gain a better understanding of the days task than had been possible in the phone interview. A second factor appeared to be in the synergy developed by having others who work on the same process present. This seemed to eliminate apprehension about how the information would be used.

6.2.2 The Value of Animated Simulation for Reengineering

Animated process models appeared to be useful in reducing the cognitive load of understanding processes. Complex models appeared to be easier to understand when show the animation than when shown the static process models. Process branches were generally shown on separate pages of the static model forcing model walk-throughs put review of one sub-process on hold while following another sub-process. In the animation model, some branches in process could be shown on the screen simultaneously.

The animation models appear to require less semantic interpretation than static process models. The meaning of the rectangles, arrows and layout in static process models is largely arbitrary whereas the animation model is iconic. When analyzing the static process models, participants had to use cognitive effort to interpret the meaning of the models, reducing effort available for analysis of the process. The intuitive nature of the animation appeared to need little interpretation.

6.3 Chapter Summary

Propositions of the study of the study were supported, although not without caveat. The reengineering process used in this study illustrates a valuable way in which organizations can use modern tools to help them design “to-be” models effectively. It is also suggested that further research into the tools and processes used is likely to lead to further improvements in the process. It is suggested that the enhanced version of focus theory presented offers more explanatory power than previous versions.

CHAPTER 7 DISCUSSION

This chapter summarizes the lesson learned and the limitations of the study followed by recommendations for future research.

7.1 Generating Insight for Reengineering

Focus theory provides a useful guide to developing processes and tool support for reengineering projects. GSS and animated simulation were used successfully to create an innovative “to-be” model.

Vested interest appears to be a more complex construct than previously described by focus theory and its level is always being affected by the process. Developing innovative organizational processes demands breaking rules that have been successful guides in the past. Breaking away is not easy and, in the early stages, comfort can be found in returning to old habits. When groups try to change, a minority of nay sayers can return a group with a fragile hold on the new to its former comfortable state.

7.1.1 Animation Improves Process Understanding

The animation model was easier to understand by the reengineering participants than conventional process flow charts. It portrays processes using a less abstract representation that requires less effort to understand and provides more information within the same display area. Increasing the amount of information that can be displayed simultaneously improves the portrayal of parallel tasks within the process.

7.1.2 Animation Improves Problem Identification

The “as-is” animation exposes some problems immediately. Problems that may not have been obvious without a complete and detailed model of the process can become apparent as the model is developed. In this case excess movement of paperwork and duplication of storage was clear in the animation.

7.2 *Lessons Learned*

The results of this study indicate that GSS and animated simulation are beneficial to the reengineering processes, however a number of lessons on how to use the tools to capture their potential were learned as well. Figure 7.1 summarizes the lessons which are described in the following subsections.

Coaching and Social Comparison Required
Vested Interest Required
Limit Information on Animation Views
Provide Reengineering Instruction and Examples
Begin Coding Animation Early
Use a Prototype Approach
Use the “As-Is” model Prudently

Figure 7.1 Lessons Learned

7.2.1 Coaching and Social Comparison Required

Critical evaluation of the reengineering groups’ ideas is critical. It is important that the group is challenged to develop aggressive improvement strategies. They may feel the job is complete after making incremental improvement which is not likely to be

enough. In this case, the facilitator and the project coordinator acted as coaches to encourage the group to consider more dramatic change.

In this case, labor efficiency rate were used to provide social comparison to the group and an example reorganization design to highlight an extreme possibility. Other forms of coaching and social comparison are possible and should be selected based on their saliency to the group.

7.2.2 Vested Interest Required

Maintaining the groups vested interest is critical and support of both the goal congruence and process accord aspect is necessary. Management support and incentives are ways of improving goal congruence. Communicating project plans and achieving intermediate goals can enhance process accord.

7.2.3 Limit Information on Animation Views

Separate animation displays were needed for analysis and presentation. Analysis screens showed a much greater amount of detail than presentation screens and allowed an analyst, either a trained analyst or a process participant participating in analysis, to see a number of pieces of the system in close juxtaposition. When a person is viewing an individual monitor, a relatively high amount of detail can be presented. Presentation screens are required to be much more simple. When the animation is shown to a group it is difficult to focus the group on a particular aspect of the animation and therefore no more detail should be shown than is necessary. Unfortunately, the differences in analysis screens and presentation screens required us to code them independently. It is possible

that future software will allow greater flexibility in hiding animation objects that would allow a single screen to be configured for use in both occasions.

7.2.4 Provide Reengineering Instruction and Examples

In addition to providing process animation to groups, reengineering examples and principles should be provided to group members to help give them guidance in the design effort. Probably a tutorial on reengineering covering how to apply design principles would have been beneficial. However, the tutorial should only be conducted after some amount of goal congruence has been achieved.

It is easy to imagine providing too much information to participants. If complete information were provided on reengineering methods, methods of computer support, organizational strategy, reengineering examples, “as-is” analysis, and social comparison data, it would likely overwhelm participants and become ineffective. An important job of the facilitator is to choose what information to use and how to present it. The optimal mix of information is still an open research question, however some information from each of the areas listed is necessary.

7.2.5 Begin Coding Animation Early

The animation appeared to be beneficial to the process even before the underlying simulation was validated. It appears that the cycle time of the process will benefit from using drafts of the animation as early as possible, without regard for the validity of the simulation. In some cases, it may be possible to make decisions without a

simulation. In other cases, simulation development may focus on only a critical subset of the process.

7.2.6 Use a Prototype Approach

A prototype approach was necessary to develop complete models. Initial prototypes were developed and presented to participants. Participants comments were used to iteratively refine the model. Though necessary, the cycles of prototyping were time consuming in that analysts made changes to the models between review meetings. Both the model development and successive meeting scheduling were time consuming and increased project cycle time. It was therefore useful to use the GSS to capture as much information as possible from a single meeting and limit the number of cycles. Future tools that allow revisions to be made to the model in real time, by meeting participants have potential to reduce project cycle time tremendously.

7.2.7 Use the “As-Is” model Prudently

The need for an “as-is” model in reengineering has been controversial with proponents claiming that it is essential and opponents claiming that it is at best a waste of time and at worst a danger to the process. The benefits of the “as-is” model are the documentation of requirements and constraints and its use in focusing a group on the scope of the project. The danger is that a groups may place too much emphasis on the current constraints and restrict themselves to designs that offer only incremental improvement.

Rules-of-thumb that were useful in the “as-is” organization such as ones of the form, “Department A should/ should not perform task B,” often must be abandoned.

7.3 Limitations

7.3.1 Limitation of the Study

The generalizability of the study may be questioned because the study involved only one organization. Since no theoretical factors were dependent on organizational characteristics, it is likely that findings apply to a wide range of organizations and processes. However, further investigation is recommended.

7.3.2 Limitations of the Simulation

It is difficult to model human behavior and the simplifications made in modeling the sales process did not always capture the true dynamics of the work place. For example, processing purchase orders was considered a high priority to those involved in the process. However, they were aware that a cycle time of less than a day was not important because orders would not be sent out until the carrier pick up at the end of the day. If the volume of purchase orders was low and it was early in the day, then their relative priority could be lowered. If the volume of purchase orders was high, they could be made top priority. This type of dynamic occurred in a number of processes, all of which are interrelated within the organization. A benefit of this type of behavior can be a more effective dynamic prioritization scheme than can be easily built into a system. A cost of this type of behavior appeared to be in prioritization errors that can occur when

the system gets overloaded such as working on the task currently demanding attention rather than a higher priority task that was interrupted. Another cost appeared to be in the cognitive load of interrupting large numbers of tasks. The net effects of these benefits and cost were not analyzed as the simulation was built at higher level of abstraction than would have been necessary to capture this dynamic. Current simulation software makes this type of investigation prohibitively costly to program, in most cases.

7.4 Recommendations for Future Research

The following areas are in need of further research. Evidence presented in this study suggest that these area would be productive areas for additional research.

7.4.1 Group Process Modeling

This project used group activity modeling tools, but relied heavily on analyst developed process models. These models were time consuming to create and were under constant change by the process participants. It would be more effective to develop the models on a group setting, similar to the way activity models are developed.

7.4.2 Simulation/Animation Software

The coding of the simulation and animation software was time consuming. It appears that object oriented building blocks, created at a higher level of abstraction than constructs currently available would greatly cut the model development time.

Another technique for managing complexity used by other modeling techniques such as IDEF0 is hierarchical decomposition. If animations could be created

hierarchically beginning with a high level view, it could potentially ease model viewing, facilitate model development, and help identify the necessary amount of model detail.

Further, if group process modeling tools were integrated with simulation and animation software, significant productivity gains could be realized. Additionally, animation models, potentially, could be developed in real time with participant interaction.

7.4.3 Integrated Tool Support for Reengineering

This project required analysts to maintain models and documentation in a relatively ad-hoc way as the project proceeded. IDEF0, simulation and animation models were maintained for consistency along with dictionaries of supporting documentation throughout the process. Since all models and dictionaries used independent tools, it was difficult to maintain consistency. It was also difficult to link decisions to their justification. An integrated computer workbench could drastically reduce the labor required by analysts and provide higher quality models.

This type of software should provide the both rich analysis support required by trained analysts as well as easy to use group support. Of course practical limitations in tool development may not prohibit a completely integrated solution.

7.4.4 Group Business Process Design

Meeting design for group business process design are still in need of further refinement. The difficult part of the process is the convergence of a number improvement ideas into a coherent plan or design. In this study, small groups were

tasked with developing competing designs followed by a session of integrating the designs. It is likely that improved tools and meeting designs can enhance this process.

7.4.5 Information Access

This study focused on providing better access to content information, namely the process animation, but provided relatively little process information about how to design processes. Some participants argued that they were not equipped to design process without training. It appears that the group could have benefited from process design training. It is difficult to assert whether these arguments were put forth due to a lack of process accord or goal congruence.

7.4.6 Effect of VIS on Understanding and Inspiration

Past VIS research has focused on subject learning and decision quality when subjects were able to interact with animation and simulation models by changing the value of model parameters. It is suggested that this work should change its focus by allowing subjects to change the structure of the model and measure the subjects understanding of the process depicted by the model and how its depiction inspires them to develop new model structures.

7.4 Chapter Summary

This study demonstrated the efficacy of using GSS and animated simulation to help groups develop “to-be” business models. It is suggested that further work on tools and processes would be fruitful.

APPENDIX A SALES PROCESS CONCEPTUAL MODEL

**A2 Sell Products
Process Flow Model
Updated 2/26/96**

Semantic Notes and Key

Task - Uppercase letters indicate person or group that performs task. Lower case letters describe task.

Decision - Indicates a decision is to be made or a chance occurrence

Bomb indicates a task or a decision has an "exploded" or detail view.

Data Storage - Title of data storage; in parenthesis storage technology

An '*' in the title of an object indicates the 'original' of the object exists elsewhere on the drawing. When collecting data on objects, just use the original.

A2.1.1 Receive Inquiries

A2.1.2 Process Inquiries

A2.1.3 Notify AMs

A2.2.1 Receive Prospect Info

TO: A2.2.2 Enhance Prospect (page 1)

A2.2.2 Enhance Prospect (page 1)

A2.2.2 Enhance Prospect (page 2)

A2.3.1 Write proposals

A2.3.2 Log and distribute proposals

A2.3.3 Monitor proposals

A2.4 Order Processing

Process Renewals

A2.5.1 Support AM sales

Figure B.2 Simulation Code, Page 1

Figure B.3 Simulation Code, Page 2

Figure B.4 Simulation Code, Page 3

Figure B.5 Simulation Code, Page 4

Figure B.6 Simulation Code, Page 5

Figure B.7 Simulation Code, Page 6

Figure B.8 Simulation Code, Page 7

Figure B.9 Simulation Code, Page 8

APPENDIX C TIME RECORDING INSTRUMENT

Sales Log
Name:
Date

- Events:
- RP - Recieve call from prospect
 - RPO - Recieve PO (note from whom)
 - RC - Return call to prospect
 - SP - Send information package to customer
 - PR - Print prospect report
 - FR - Fax prospect report
 - SN - Send non-disclosure form
 - WP - Write proposal
 - SP - Send proposal to customer and AM
 - PPR - Print proposal report
 - SPR - Send proposal report
 - IG - initiate green sheet and copy

Event Type	Start Time	End Time	Quantity	Work-Hours

Figure C.1 Time Log Example

Receptionist Log

Name:

Date:

	For Individual	Transfer to Sales	Transfer to Admin	Transfer to Tech	Transfer to Cust. Supp	Recieve PO	Other
7:00 AM							
8:00 AM							
9:00 AM							
10:00 AM							
11:00 AM							
12:00 PM							
1:00 AM							
2:00 AM							
3:00 AM							
4:00 AM							
5:00 AM							
6:00 AM							

Figure C.2 Receptionist Time Log

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