To the Graduate Council:

I am submitting herewith a thesis written by Sowmya Thiagarajan entitled "A Strategic Approach to Information Systems Analysis and Design." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Industrial Engineering.

Dr. Denise Ford Jackson, Major Professor

We have read this thesis and recommend its acceptance:

Accepted for the Council:

Associate Vice Chancellor and
Dean of The Graduate School

A Strategic Approach To Information Systems Analysis and Design

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Sowmya Thiagarajan
December 1995

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DEDICATION

I dedicate this thesis to my parents,

Thiagarajan and Pattammal

who taught me the value of education;

and my husband,

UdayaKumar

who helped me achieve it.

ACKNOWLEDGMENTS

I sincerely thank my adviser Dr. Denise F Jackson for encouraging, supporting, caring, and providing strong guidance throughout my studies in the Industrial Engineering department.

I thank Dr. C. H. Aikens, Dr. E. Deporter, Dr. J. A. Bontadelli for providing me quality education and support during my studies at the University of Tennessee.

I thank my boss at work, Mr. Michael. A. Schmidt for providing all the right opportunities and encouragement in accomplishing each of them. Without these opportunities, this study and the validation of its results would have been difficult to complete.

I thank my project leaders at work, Mr. Horace Greening, and Mr. Carl Lawson who encouraged my research and supported my study by providing valued information from their experiences.

I thank all other project leaders at work Pam, Jim, Allen, Gary, and Barry for sharing their past experiences during this study.

I thank my colleagues at work Joe, John, Mike, and Margaret for creating a fun atmosphere at work and therefore making this difficult period seem simple. I thank my friends, Chitra, Poornima, and Rama for encouraging me throughout my studies.

ABSTRACT

This study has re-designed the traditional system development process by addressing its lack of efficiency, effectiveness, and quality in analysing, designing, and delivering information systems to its customers. A strategic approach to information systems analysis and design has been created. This approach involves strategies such as organizational planning of information strategies, research of business processes and the role of information systems, business process re-design/re-engineering along with information technology, and design of new information system for the re-designed processes through prototyping. The majority of the problems arising due to the lack of users and IS personnel communication have been addressed by incorporating techniques such as Joint Requirements Planning and Joint Application Design. A new way of documenting business processes and their information flow has been implemented within the development process in the form of process models. This approach has been structured as a strategic development process model and therefore has identified the Focus, Objectives, Enablers, Critical Factors, and Tool Support for each phase of analysis and design of information systems.

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Chapter I

INTRODUCTION

Attracting, satisfying, and retaining customers is the goal of any business process. Reaching that goal is facilitated by the availability of timely, accurate information. Thus, information is a critical resource of any organization and must be successfully managed. That management of information processing includes planning, controlling, organizing, and decision making functions, just as it would any other business process.

Whether or not information processes are automated, real-time, day-to-day decisions are made from their output. By providing the right information, with the right structure, at the right time, automated information processes have a high influence on the productivity and outcome of business processes.

Businesses are facing tremendous amount of competition and pressures. For the most effective and efficient information processes and management of those processes, businesses are increasingly depending on information technologies.

Automated information processes, however as part of an information system which uses information technologies, have a greater impact on the operation and management of business processes. Alignment of information technologies to business processes have eliminated tedious, manual documentation of business information, and the errors which result from them. Technologies have eliminated the excessive paper

flow within organizations. It is much simpler, easier, and faster to track or update information by using an information system. Information Technologies have proven, and are proving, to be significant and substantial benefits to business processes by simplifying and expediting their tasks.

Background

Information systems use information technologies to capture, store, retrieve, and manipulate data to create information which may be transmitted and presented in a manner and format suitable to the needs of one or more business processes. Different types of information systems such as decision support systems, executive information systems, management information systems, marketing information systems, manufacturing information systems etc., are being developed and implemented for usage in today's industries to serve different purposes for different business processes.

These business processes represent activities which consume resources to create something of value to internal or external customers. Together the business processes provide the mechanism by which the organization responds to the demands made by elements in its business environment. That environment includes the organization its competitors, suppliers, and customers and the conditions (demographic, social, and economic) under which it must operate. Thus information systems may be considered sub-systems of business systems or business systems themselves. Therefore, the IT's

used in IS's must be aligned with the business systems which they are a part of or to which they provide support.

Traditionally technology is aligned to already existing business processes. The business processes are not questioned and re-designed to meet current goals of the company or to become more efficient. This approach to automating business processes does not provide significant benefits and dictates the business processes to adapt to them rather than fit the technology to the process. This approach rarely provides expected positive results. In fact, Davenport et al (1990) state that "information technology alignment to processes will not be effective unless the business processes themselves are questioned and re-engineered".

Even after business processes are re-engineered and information systems are aligned to them, IS organizations are still struggling to add value to the business processes. Their productivity do not measure up to the expectations of the business processes. IS organizations are being considered as "cost-adders" rather than "value-adders" for the company. IS projects are taking a longer than scheduled delivery time, users' expectations of the systems are often not met, and costs are exceeding beyond budget. The next logical step for IS organizations is to determine how their processes can become more efficient and fulfill their customers' requirements and expectations. To build on the concept of Davenport et al (1990), process effective implementation of information technologies will not occur and add value to the business processes until the information systems processes which are associated with the business processes and

which incorporate the information technologies, are themselves questioned and re-engineered.

Problem

The information systems processes include development, maintenance, planning, project management, and client support. Among the IS processes, the foremost and important process is the development process, since it is the one which performs the activities responsible for analyzing, designing, developing and delivering the information system product to its customers and all other processes are only its support processes. IS development is the main process which determines customer requirements for IS products and fulfills them. When the development process is efficient and effective the need for support processes such as maintenance, problem management, client support can be reduced significantly or even eliminated. This benefits the IS organizations in the form of savings in resources. Thus the development process has the highest potential for savings in resources.

Most IS organizations are still following the traditional waterfall method (originally presented by Royce) of system development. With some variations in the number of distinct stages, a simplified version of three steps include analysis, design, and implementation. The traditional system development life cycle does not meet contemporary business needs. However, Eliason describes the time requirements as

25% for analysis, 25% for design and 50% for implementation, and costs of 30%, 30%, and 40% respectively.

The pressures to adopt commonly accepted methods of systems development are so great that the advantages of deviating from them have been overlooked by the IS organizations (Raghavan et al, 1992). Even experienced managers find themselves in the midst of seemingly unmanageable projects in spite of following all established guidelines for systems development. Some examples that Raghavan et al say are, Overdoing the user interviews which ends up in increasing the users' expectations beyond reasonable scope; Documenting and designing a large project without actually delivering all the requirements in time; Overdoing analysis and design without using the entire results for actual construction.

IS organizations are failing to realize that what they perform is also a process and that, a process has to be re-engineered from time-to-time not only to improve its efficiency but also to change its methods to meet contemporary requirements. It is time that IS organizations questioned text book guidelines and common practices of an information system development process (Raghavan et al,1992).

IS processes must be re-engineered in order to be considered value-added activities with respect to the business processes. In aiding the IS organizations to reach their goal to build effective, high quality systems, in a timely manner, that generate increased business benefits with sharply limited resources, this thesis will address the lack of an efficient and effective IS development process for today's business

environments. The effort of this study will be approached with the objective of creating a development process with maximum effectiveness and quality with regard to customer satisfaction. This approach is being adopted because customer satisfaction is the ultimate goal of any IS product.

General Approach to the Problem

The strategy of the research will be first to collect, identify, and evaluate development process practices, and to determine issues surrounding them. Secondly, it will identify the most encountered problem or problems within the development processes of most IS organizations. Information will be obtained through extensive literature research. Since, the IS industry is vast and has varied technologies, practices, and purposes, there is no one practice that will fit every IS organization. Thus, it is essential to study development processes in different environments to identify baselines and commonalties also, an actual development project will be observed and analyzed to include in the development of a recommended, improved process. Next, an IS organization will be used as a case study for over a period of four months to validate the new results of the process.

The solution that this thesis will arrive at may be utilized by IS organizations, and incorporated within their development methodology suitable to their technical environment and organization. Thus the approach of the thesis will ensure that the solution can be adopted by any IS organization with any environment.

Organization of Thesis

Chapter 2 is a literature review of current situations in IS organizations. It discusses the problems and deficiencies in existing traditional development process. It also discusses issues related to the productivity of an IS organization. Chapter 3 discusses the methods in which research was conducted. It also discusses the approach in which the solution methodology was formed and structured for the problem identified by the thesis. It also discusses the projects whose development approaches were analysed and the case study which was used to apply the newly formed methodology. Chapter 4 provides the solution structure and discusses the structure in detail. Chapter 5 summarizes the solution provided by the thesis and provides conclusions and recommendations which resulted from the study.

Chapter II

LITERATURE REVIEW

Introduction

IS organizations have not questioned their processes for a long time. Although there have been tremendous changes in technology, many have not invested in newer tools, or adopted newer concepts, techniques, or approaches. Most of them do not realize the benefits that can be achieved by changing or improving existing systems. Many of them do not have a system's perspective in reviewing the purpose of their efforts, or even their existence.

This situation cannot continue if IS organizations are to be a viable part of their companies' future. Sooner or later every organization has to re-think its procedures and replenish its tool sets or it will find itself extinct. This is critical, if IS organizations are to help companies obtain and maintain a competitive advantage.

The following literature review will describe the various situations that exist in most IS organizations today and emphasize the need for dramatic changes in development approaches.

Re-engineering IS Processes

IS processes fall broadly into several categories such as Development, Project Management, Customer Support, Technical Support, Quality Assurance, Systems Administration, Systems Management, and so on, depending on the structure and size of the IS organization. IS organizations may have a few, all of the above processes, or even additional processes. An overwhelming amount of IS organizations fall into the group which has very few of the above processes. Most of the processes lack a formal structure or are still conducted in the old fashioned way. New techniques, concepts, and tools are not considered and tried (Raghavan et al, 1992). Many IS personnel resist change, and that has hindered the improvement of the processes. But those business processes which the IS organizations are supporting with technology alignment are being successfully re-engineered with new concepts and techniques every day. It has been proven that information technology alignment will not prove to be effective unless it is planned parallel to the re-design of the business process.

But IS processes have not changed to accommodate the re-engineering efforts of business processes and the increasing need for customer information systems which support or enhance the business systems. According to Davenport et al, M. Hammer, Schnidt and other pioneers of BPR, re-engineering should be performed with information technology in mind and re-engineering with IT can be best done only when IT personnel are also included in the re-engineering effort. But IT is aligned to the business process by the system development process. Therefore, in order to re-engineer

business processes with information technology, the system development methodology should provide a separate phase for business process redesign before actual design of the IS application and its actual development. This provision for BPR is not available in the traditional development methodology.

IS organizations have failed to see the connection of what they do, and how they do it, to the business goals and objectives. What is lacking is a systems perspective which reviews the company as a system operating within an environment and composed of sub-systems which have processes that connect inputs to outputs to meet a demand from an external entity. Because an evaluation is needed at the process level the following provides a description and depiction of processes as they are viewed in this study.

Process

A process is a set of activities which act on input(s) to produce the desired output(s). A process may be composed of several activities. Each activity may in turn be composed of several sub-activities. A process can thus be decomposed to several sub-levels. A process has its boundaries. The boundaries of a process start where the inputs enter the process and end where the outputs exit the process. A process is conducted through the completion of a set of activities in a certain determined order. Inputs and Outputs of a process may be in any form. The order in which a process performs is regulated by several procedures, rules, and constraints. A process is

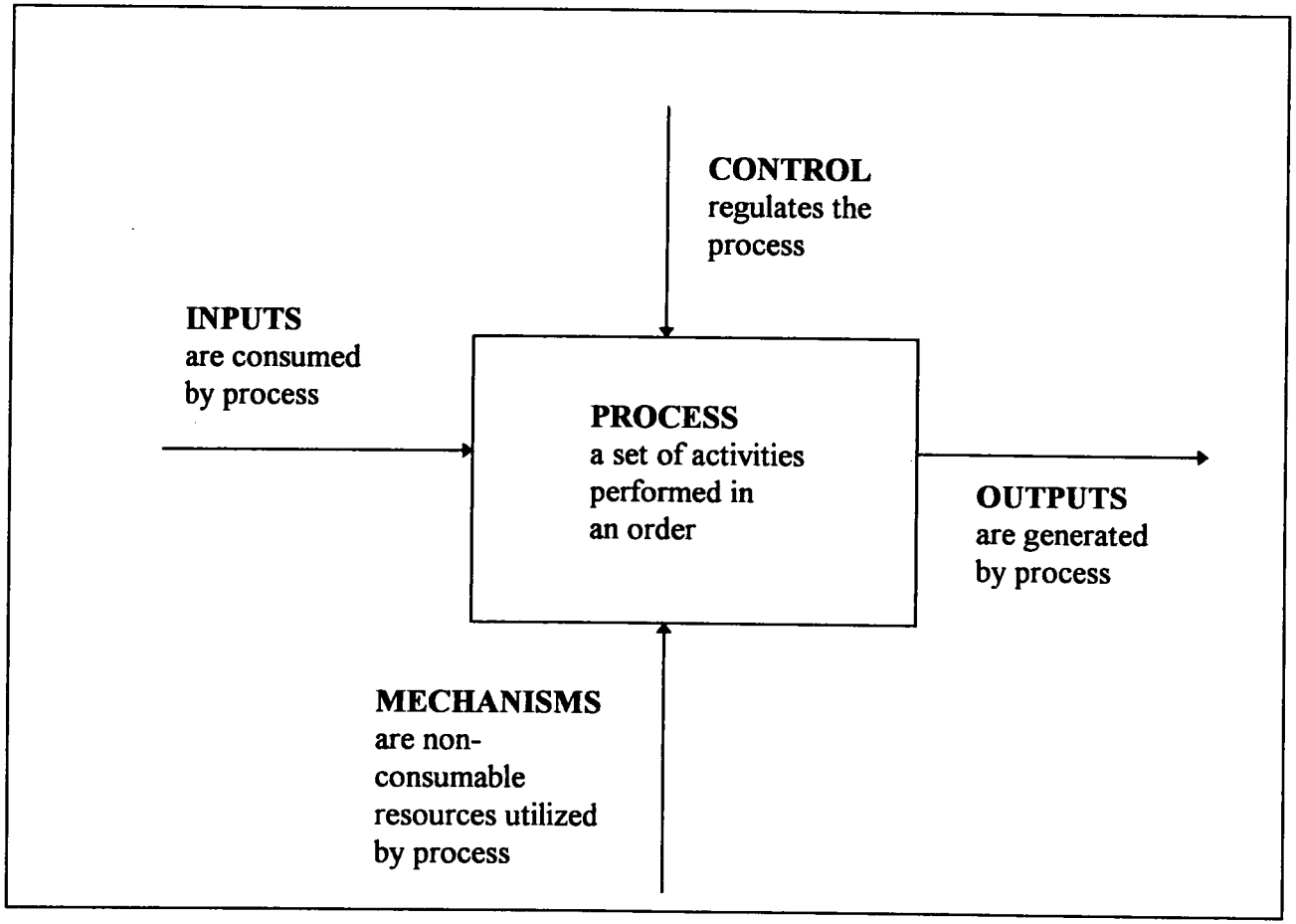


Figure 1: A Process Model

conducted utilizing various resources such as tools, manpower, skills, techniques, concepts, and information systems. Figure 1 shows a process representation within a process model.

IS Development is also a Process

Information Systems development is also a process. It receives customer inputs through systems analysis, develops a design from the inputs, programs the application according to the design, plans for deployment of the application, implements the application in the customer's world, and stabilizes the system through effective post-implementation monitoring and evaluation. The outputs are the system it develops, the training it produces, the documentation it produces for the users, and so on. Figure 2 shows the context diagram of a system development process.

The development process has several phases with sub-processes and their individual activities. When performed collectively in a particular order, the activities will produce information systems for the IS customer.

The Traditional IS Development Process

Most IS organizations have been and many still, are following traditional systems development life cycle methodology or the step-by-step waterfall method to develop information systems for business processes (Kendall, 1990). The traditional systems development life-cycle methodology has seven phases. They are, problem

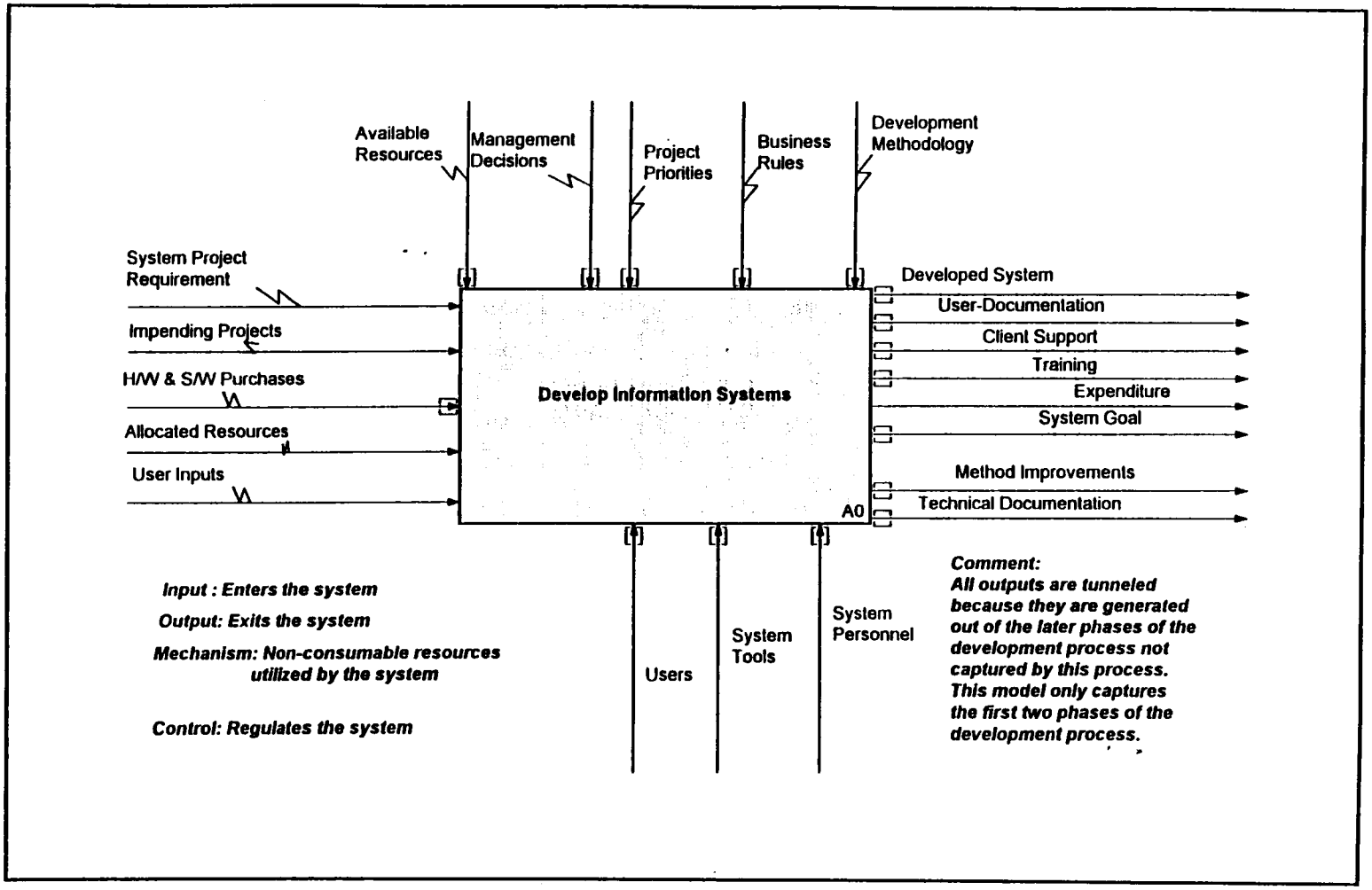


Figure 2: Context Diagram of a System Development Process

recognition, feasibility study, analysis, design, development, implementation, and maintenance. Each phase follows the other in a sequential manner. Various activities are defined within each phase of the methodology. Each phase has its principal tools, models, diagrams, specification requirement formats, documenting tasks defined within it. The result of each phase spills into the next and each phase must be completed in an orderly fashion. The traditional system development life cycle is shown in Figure 3 as described by Kendall.

Initially the management identifies system needs in business processes as a potential IS project. One or more systems analysts are assigned to the project to define the project goal and objectives. A feasibility study of the project is conducted to evaluate resource requirements and determine costs/benefits to decide whether the project should be pursued. Once the decision is made by the IS manager and the business management to pursue the project, further analysis of the business area is performed. Processes in the business area are identified and defined. Information requirements of the processes are documented. users, business managers, and other business representatives are interviewed to identify current processes and new system specifications/requirements. Business functions and Business rules are also documented. Data requirements are defined and data models are created.

Principal tools such as, data dictionary, data flow diagrams , data models, system models, prototyping, system flowcharts, and Warnier-Orr diagrams are developed. Data dictionaries are a compilation of definitions for all data stores, data

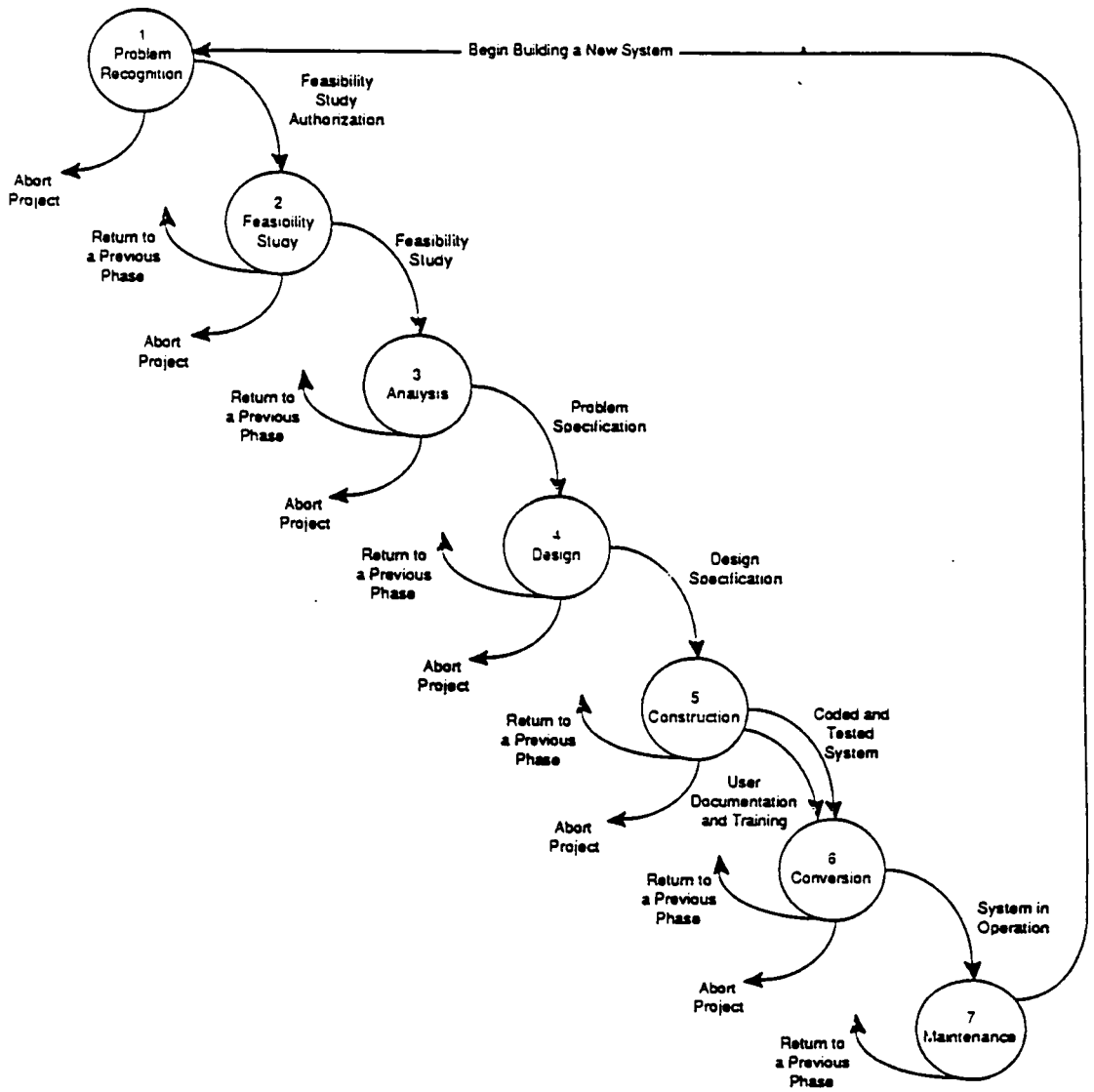


Figure 3: Traditional System Development Life Cycle

elements, data flows, and processes of a system. Data flow diagrams are used to show the flow of data through an information system and the functions performed on and with the data. Data models are graphic representations of the data structure of an information system; Examples are entity relationship diagrams, data structure diagrams etc., that capture data structures and table relationships. Prototype is a model that is an abbreviated version of a new information system. System flowchart is a type of graphic model that is used to show the major inputs, outputs, and procedures of an information system. Warnier-Orr diagrams are hierarchical graphic tools used to represent the tasks that an information system must perform.

Next, the systems analyst(s) designs the new system or application. In this phase the screens and their functions are designed. Here too, tools such as data dictionary, data flow diagrams, data models, system models, prototyping, system flowcharts, Warnier-Orr diagrams, structure charts, HIPO charts, and input and output design forms are developed. Resources are acquired, complete system functionality is determined, work flow for further activities are also identified. In the next phase the developers code the programs. Testing of the application is done and documentation is also completed. Implementation of the new application is done next and the users start using them in day-to-day operations. The next phase i.e., maintenance of the application, starts where the system is repaired and upgraded.

In the traditional methodology activities are performed in sequence one after the other. Each phase has to wait for the other to be complete. Too much time is spent on

the requirements specifications. Systems analysts spend too much time interviewing numerous people over a long period of time. Excessive time is spent in documentation. Too many tools are used to represent the system and its functions in various forms as identified above. Too many diagrams and models are created to represent the same information. Even before a project is defined, often there is pressure to evaluate the needed resources and the project schedule (R.B.Grady, 1992). Typically projects invest about 18 percent of their total effort during specification requirements i.e., analysis, about 19 percent during design, 34 percent during coding, and 29 percent during implementation. Various organizations have measured their projects and their results vary from these estimates by plus or minus 10 percent (W.B. Foss, 1993). If too much time is spent on a project, the requirements of the project itself might change before its completion . This requirement creep makes the project completion data a moving entity in time and turns the project into a program. Some authors, however, state that requirements creep is a reality of doing business and that defining system requirements can not be done effectively if systems have to be delivered in time as scheduled (D.S. Corbin, 1991).

Today, however customers want the system delivered yesterday in order to be prepared to compete tomorrow. So instead of rigidly following the traditional methodology, developers try to skip steps in the methodology or shorten the early phases by directly jumping to development after a brief performance of the early phases. When choosing to skip certain steps they fail to prioritize or weigh the importance of

the steps they are skipping and therefore often commit costly mistakes. They fail to conduct a thorough systems analysis and to confirm user expectations of the new process and system, or they do not prepare a good prototype to reach concurrence with the customer application requirements, that results in extensive time making corrections maintenance in order to correct mistakes that could have been identified early in the project. In fact, Alter indicates that the costs of detecting errors and making corrections increases exponentially over the duration of the project. Figure 4 demonstrates the importance of identifying design errors early in a system development process by showing how the cost of design errors escalates the later they are discovered.

When Hewlett-Packard conducted a customer survey about how much percentage of their work time their people spend doing corrections during maintenance, the average response was 75 percent (R.B.Grady, 1992). This, they have explained, may be due to improper systems analysis, defective coding, inefficient testing, or inadequate understanding of the customer needs or other mistakes. In other words, they are saying that mistakes may occur during any phase of the development life cycle. Thus, effectively performing all phases is critical to creating a useful system. An American Management Systems study revealed that 75% of all large systems can be considered "operating failures" in that they are not used at all, are not used as intended and/or generate reports that are meaningless. Many of these situations may be contributed to ineffective or incomplete systems analysis efforts (C.A. Dykman et al, 1991).

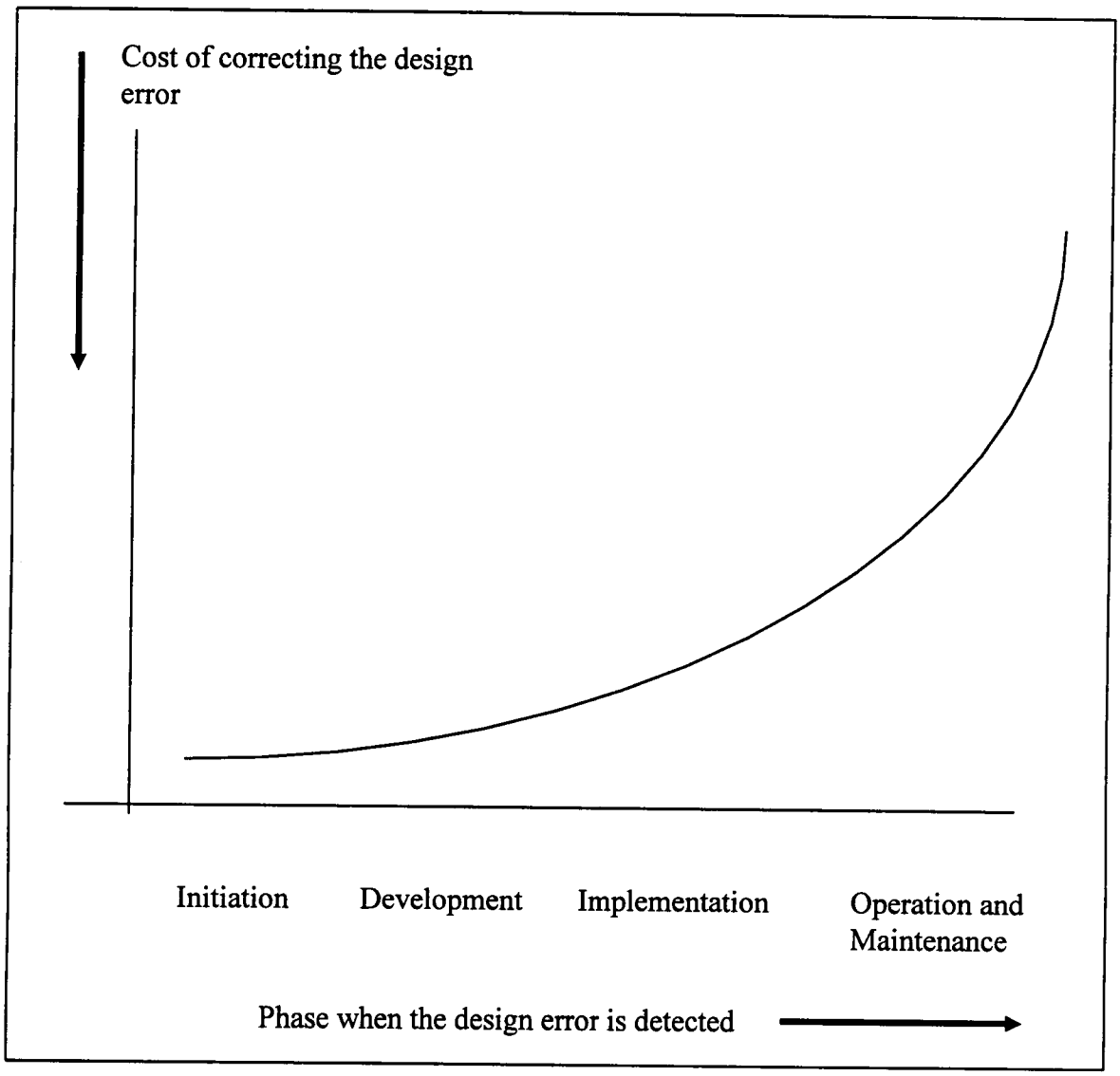


Figure 4: Cost in Design Errors Detected at Different Times

A 1991 Peat Marwick survey found that 35% of all major IS projects are "runaways"--hopelessly over budget and still not completed (C.A. Dykman et al, 1991). A recent study by First Market Research has found that 80% of IS projects go over budget and schedule because system changes occur after requirements are frozen (G.H. Anthes, 1994). Anthes raised two questions: (1) "How often does requirements creep impact budget/schedule ?". (2) "What impact does requirements creep have on cost and/or schedule ?". For the first, only 20% of 160 respondents answered as "seldom". The rest 80% agreed to "Always" or "Frequently". For the second, 9% of the respondents agreed to "Major "(More than 50% cost overrun and/or schedule slippage). A few agreed to 0 to 10% cost overrun and schedule slip. The majority of respondents agreed to a moderate impact of requirements creep to be often an 11% to 50% cost overrun and/or schedule slip. Terry Marksberry, CIO at the Meredith Corp., says his company had to scrap a nearly 10 year old development project whose creeping requirements pushed it to three times its original budget. M Gentle, a project manager at SmithKline Beecham Pharmaceuticals in Paris says "The ripple effect of incorrect and incomplete requirements through the life of an application is the major contributor to out legendary woes: high costs, low returns, eternal maintenance, and dissatisfied users" (M. Gentle, 1994).

Scope creep is another widespread problem in the IS industry. In a survey by First Market Research Corp. 44% of the respondents say that poor initial requirements definition is the leading cause of requirements creep. 22% of respondents say,

management failures after the requirements definition phase as a reason for requirements creep. 36% agreed that requirements creep is often due to new applications unfamiliar to users, 28% agreed that projects take so long that requirements genuinely do change, 19% identified the reason as, failure to involve users in early stages, and 6% agreed that failure to employ techniques such as prototyping or Joint Application Design may be a reason. Another cause or of requirements creep is written specifications that are ambiguous or inconsistent. Another similar research confirms this fact by saying that 75% of all systems errors result from poor quality specifications (D.C. Andrews, 1991). A KPMG manager says that IS managers often contribute to the problem by doing a poor job of managing expectations - both users' and senior managers (J. Willbern).

IS organizations must do requirements engineering and they must do it right. It is important to the downstream efforts and has too great an impact on the cost and schedule to continue to be done sporadically and inconsistently. According to Athens, IS organizations have to improve their requirements specifications process and be aware of the problems associated with it (G.H. Anthes, 1994).

Absence of IS and User Communication

Many IS organizations have not been involving the users in the systems analysis and design effort. Often only selected business managers would be involved in the system analysts' interviews. This causes a big problem in defining accurate

requirements specifications. Users are more aware of day-to-day problems of the current systems and the business processes than the business managers. Business managers are not aware of users' issues. Mis-communication very often occurs between users and business managers. Of all runaway projects 93% stem from poor communication says a KPMG's Runaway Systems Management Group's 1994 Survey (R.Garner, 1994). Too many systems development efforts create the wrong system, create it inefficiently , fail to make sure it works properly, or create it in a form that is difficult to maintain. Alter says that systems miss the mark frequently enough that the picture in Figure 5 has become a cliché for system developers.

User Satisfaction and Support

Failure to accurately take users' pulse is a common mistake in IS departments. A project succeeds only when it has solid user backing (D. Asbrand, 1993). All IS managers are realising the importance of end-user satisfaction. IS organizations have to accept the reality, that they are, service organizations. They exist to meet the needs of end-users, their customers. Therefore, their survival depends on customer satisfaction. Many IS organizations still have not established the right set of measures to find out whether their customers are satisfied. Those which have measures, have not ensured that theirs are the right set to provide them adequate feedback or to indicate their concern and commitment to the users. Even if they have a customer survey process, often the surveys are designed badly and ask the wrong questions (D. Asbrand, 1993).

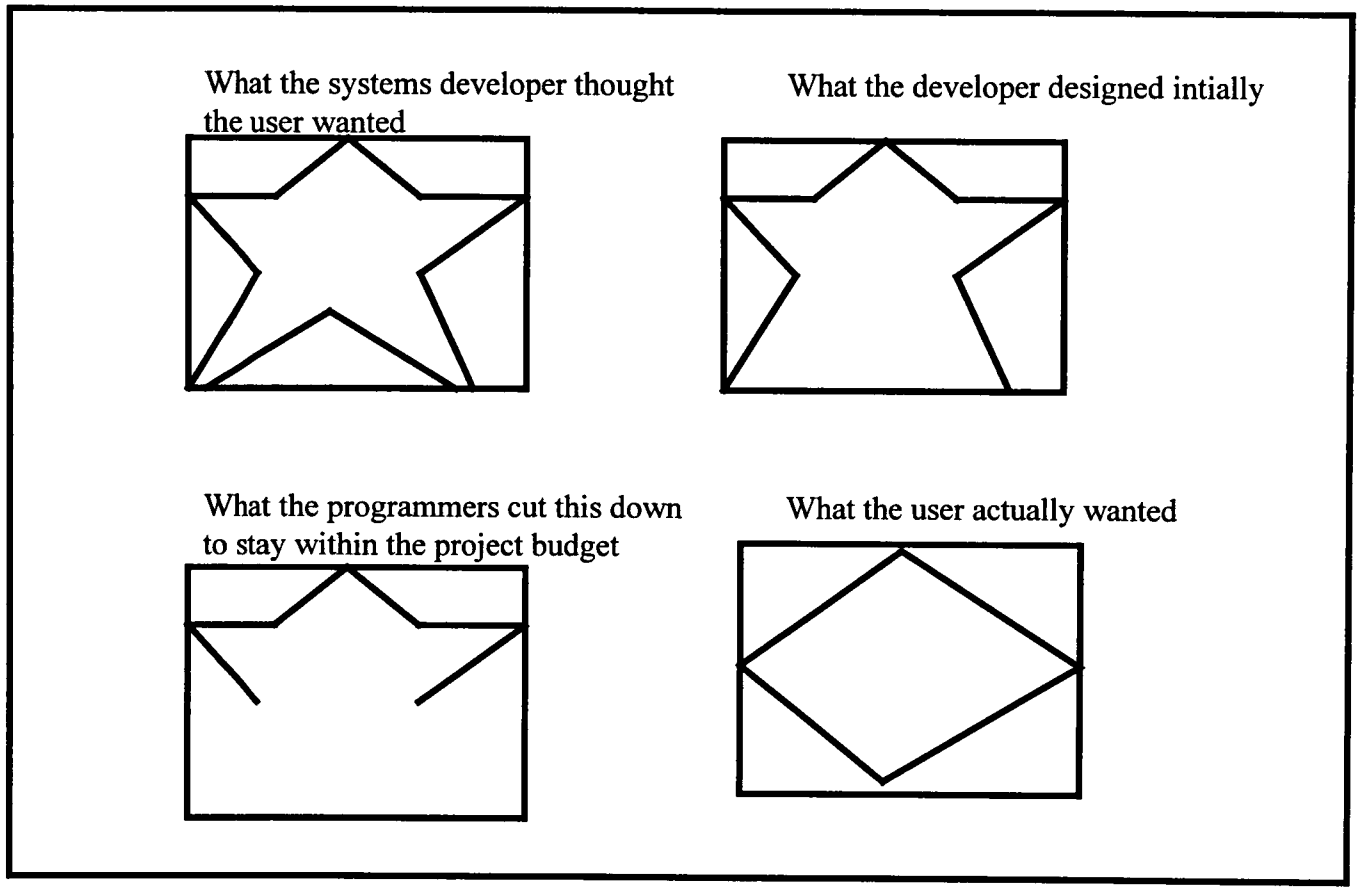


Figure 5: Dilemma that has Frustrated a Generation of System Developers

IS staffers need to adopt the point of view that customer satisfaction measures are in their own best interest. A good channel of communication with users give IS departments repeated opportunities to promote their ideas for new technologies and new ways of doing business, and to foster confidence in their services and products. This generally is accomplished through customer support.

Many IS organizations, however, do not have a strong user-support function. In some organizations, there is a lack of structure to the user-support process, and in many, it is practically non-existent. Timely support in using an IS product is the most important service an IS organization should provide for its customers. As end-users become more sophisticated, structured support is more important (D' A. Fischer). A well-defined and designed support organization provides direct end-user support and training, innovations to the working environment, consulting and the necessary support management. These activities create repeat customers and continued existence.

Organizational Barriers to IS Development Process

When undertaking large information systems development projects in a large bureaucratic organization, system professionals encounter at least four hypothesized categories of organizational obstacles, (1) bureaucratic complexity, (2) personality conflict, (3) technical complexity, and (4) acute resource scarcity (K. G. Jin, 1993). These barriers can impose major constraints on MIS project implementation, calling for effective coping strategies. Jin's framework includes non-exhaustive action strategy for

overcoming organizational barriers to systems development in large organizations. Overcoming bureaucratic complexities affecting systems development adversely should be given high priority if the MIS project participants in a bureaucratic setting are to achieve the most cost-beneficial outcome from information systems development projects. The other three issues then need to be addressed realistically within the context of bureaucratic organizational constraints.

Strategic Traps in IS Development Process

In spite of the numerous guidelines offered to manage software projects, effectively managing software development remains an elusive exercise to many practitioners (Raghavan et al, 1992). Even experienced managers find themselves in the midst of seemingly unmanageable projects in spite of following all established guidelines for systems development. Raghavan et al have identified some traps in systems development and developed axioms from them that IS managers could utilize to improve their performance. Table 1 shows traps and axioms that Raghavan et al have developed. Software development is a highly creative process and the environment in which a system is developed and implemented is filled with frailties of human factors.

Table 1: Traps in Systems Development and Axiom Solutions for Them

Trap	Axiom
Reinventing the wheel	If a system to meet most of an organization's needs can be bought from elsewhere at a lesser cost then developing, it should NOT be developed in-house.
Overdoing interviews without delivering anything	Managing the timing and extent of user involvement in system development is critical to the success of new systems.
Overdoing quality assurance	Objective quality measures in an area not central to the project should be evaluated subjectively.
Documentation without deliverance	Demonstrate to the users that a system is being developed.
Diminishing marginal returns of additional personnel	Additional personnel beyond a critical level, may actually cause a decline in productivity.
Overdoing testing	Intensity of testing should be based on the significance of the module being tested.
Over-modularizing the coding	Integration needs may offset advantages gained in modularizing the code.
Providing a state of the art development environment	The newer a technology the greater are the chances of misconception.
Overdoing analysis and design without construction	Some construction before complete analysis and design may sensitize the project team to impending pitfalls.
User-Friendly front-ends	User-friendly front-ends can entail high costs of training and maintaining and so can generate barriers to developmental effort.

IS Organizational Productivity

Michael Tracey et al have illustrated in an article on "Customer Intimacy and Other Value Discipline" that successful companies focus their energies on delivering operational excellence, customer intimacy, or product leadership. To prosper, a company must continually strive toward superiority in one of the three areas, maintaining basic competence in the other two (J. Dempsey et al, 1995). Trying to do everything well means that resources will be wasted, resulting in a mediocre overall performance. The focus of operational excellence is best total cost i.e., low price, high reliability, and hassle-free basic service. The focus of Product leadership is on best product i.e., product features that deliver results and Customer intimacy is best total solution i.e., valued advice, brokered solutions, and tailored basic services.

This need for focus has important implications for the IS organization as it seeks to improve productivity. Companies that are product innovators aim for market leadership and they typically emphasize speed over cost-effectiveness. An operationally excellent company typically demands an efficient, cost-effective IS organization. Companies that value customer intimacy will compromise on speed and cost-effectiveness for high customer satisfaction. Thus, the definition of IS productivity is not universal but depends on the setting (J. Dempsey et al, 1995).

IS productivity differs from traditional efficiency. Measures of output divided by effort do not provide an adequate definition of IS productivity. Three aspects of IS

productivity can be rated to present a composite picture (J. Dempsey et al, 1995). Speed, focusing on reduced time to business results, striving for a series of small successes; Effectiveness, focusing on optimizing use of resources, implementing a structured environment, leveraging package-based solutions; Quality, focusing on performing reliability, exhibiting fitness for use, tailoring solutions.

IS organizations have to concentrate on developing their comprehensive strategy to obtain productivity benefits by improving the above three measures. To do this successfully IS organizations have to bring themselves closer to the business culture and objectives of the enterprise. IS organizations also have to document the performance of their operations by developing operational metrics to ensure the above three measures are met. They need a baseline for performance upon which continuous improvements can be made and measured.

Benchmarking

IS organizations have to adopt benchmarking techniques to determine best IT practices of the industry. A few organizations have come to realize the importance of benchmarking. One is American Express, a leader in its use of Information Technology. American Express engaged an IBM consulting group to benchmark its IT management processes against 17 other company's. The study focused on how a company's management processes used IT to achieve its business goals. It sought to

identify the best practices for developing strategic plans that both aligned IT with the business and dealt effectively with change (P. Prairie, 1993).

But benchmarking techniques have not been widely implemented because they require measurement and many IS organizations lack a mature measurement program and lack an understanding of the aspects of IT performance that should be benchmarked (H. A. Rubin, 1995). One source of the problem is that IT measures are thought to be overhead and are not evaluated in terms of the value they add. Even when attempted, some sought, in vain, the best measure instead of seeking a suitable one. IS is also under pressure to reduce expenses while producing more work. Many are resisting baselining and benchmarking for all the wrong reasons (H. A. Rubin, 1995). Less than 10% of software-producing organizations world wide has any kind of ongoing measurement program. Only one out of six organizations that start measurement programs is successful. Software Engineering Institute(SEI) of Carnegie Mellon University in Pittsburgh has classified an organization's software process maturity into one of 5 levels. Level 1 is the Initial level, where there is no formalization of the software process; Level 5 is the Optimizing level, where methods, procedures, and metrics are in place with a focus on continuous improvement. According to SEI 80% to 86% of organizations in the US are at level 1 (H. A. Rubin, 1995).

IS organizations have to realize that benchmarking clearly provides a context for assessing IT performance, business contribution, and competitive positioning. The real issue for IS organizations is how to transform performance and produce business value

through computing. In this context metrics are a core competency that an organization must develop to promote learning and continuous improvement. To be a success, a measurement program should be adopted to add value to the processes.

IT and Business Strategy Alignment

Information technology has essentially become the driving power of Business Process Re-engineering. IT is the primary interface between the company and its customers. The IT industry is experiencing rapid advances in technology and applications. During the last decade, spending on IT by most large corporations has skyrocketed. Each worker in the service sector is now said to be, on average, supported by $9000 of computing power, and IT, is the largest item in the capital spending budget of corporate America: almost a third of all expenditure (D. L. Schnitt, 1993). thus, IT is a resource which must be used effectively in performing work activities. That effectiveness is not always achieved, however.

The most significant cause for failure to realise dramatic levels of improvements in work performance when IT is aligned to business processes, is the overlaying of IT upon upon an existing process structure (S. L. Huff, 1992). This is true, even when the best and most advanced information and communication systems is applied. It has been well established that business processes have to be questioned and re-designed, when planning to develop information systems for them. Although several methodologies for re-engineering have been proposed by many over the years (T. H. Davenport et al, T. R.

Furey, M. Hammer, J. T. C. Heng et al, N. Venkatraman, D. L. Schnitt), organizations are still failing to achieve expected levels of improvement in performance. This is primarily due to the lack of a system's perspective on the strategic impact of IT-driven redesign. When considering information technology for implementation, not only do they omit to align IT with their strategic plans, they also do not perform organizational information planning (C. C. Cole et al, 1993). That is to say that they do not look at the overall implications and sequences of information flows generated by the various functional elements such as order processing, material management, inventory control etc., They fail to see the commonality of its purpose in the organization and view information simply as blocks belonging to different functional elements ((C. C. Cole et al, 1993), (J. T. C. Heng et al, 1994).

Organizations have to determine their information strategy along with their business strategy by realizing the relationship existing among information flowing through the different functional groups and understand how they impact upon each other in influencing the overall decision making process. Without the necessary information delivered accurately and on time, business processes cannot be conducted or managed in a smooth and efficient manner to serve the customer. In a recent study an IBM consulting group benchmarked effectively the best IT-practices of 200 companies with superior performance in a wide range of industries. They concluded that the companies who have the best practices in their use of IT, have a well-structured and well-explained IT planning strategy closely integrated to the business planning process, where the

planning horizon include, both short-term and long-term objectives (P. Prairie, 1993). In other words, these companies recognize the role of IT in achieving their strategic objectives.

Even when the significance of IT 's role as a strategic enabler (as opposed to just being an automating tool) is realized, there is a lack of knowledge, among the groups involved in re-engineering, about the actual role that IT should be playing (T. H. Davenport et al, 1990). IT personnel who have the expertise in applying IT for automation, should understand the significant role that IT will be playing in achieving their organization's objectives. As re-engineering itself is an integrated and radical redesign process which removes functional segregation of information in an organization, the re-engineering process should involve representatives of different functional groups providing joint efforts, realizing the overall purpose of redesigning with IT. Thus, the leg to successful re-engineering of any process, IS or business is to utilize IT to take a system's perspective in redesigning value-added processes within a system development process.

Then, the improvement of business activities, with regard to their information value, will not only provide cost benefits but will also improve the actual value delivered to a customer. Thereby, it will open gates for better competitive positioning of an organization in the industry.

In order to respond to new opportunities, businesses may strategically change the way they operate internally, as well as alter the relationships among them and their

suppliers, customers, and rivals (T. H. Davenport et al, M. Hammer, S. L. Huff, D. L. Shnitt, N. Venkatraman). For example, Wal-mart is reported to have invested over $600 million in information technology to facilitate sharing point-of-sale details to a group of 2000 selected vendors. Firms such as Dillard, Kroger, Kmart, and Target have established alliances with manufacturers to utilize joint measurement techniques and information sharing commitment from involved parties to link logistical efficiency with marketing effectiveness (M. Ligeti, 1994). Other firms have taken steps to re-engineer their processes to improve their market positions, and most have tried to utilize IT to enhance the re-engineering process.

Various methodologies have been proposed, by many experts, to perform effective re-engineering utilizing IT during all stages of the re-engineering process(T. R. Furey, C. L. Harris, S. L. Huff , N. R. Stewart, Heng et al, Grover et al, Davenport and Short). Even after substantial re-engineering work has been done, and efforts have been taken to educate the organizations in considering IT as a strategic enabler, some organizations are still noticeably failing to achieve much performance improvement. Many are using IT only as support tool. Incomplete management involvement throughout the entire re-engineering process and failure to align IT with the organization's strategic plan have proven to be expensive mistakes. Davenport et al say that the greatest difficulty in IT-driven redesign is "getting and keeping management commitment" (T. H. Davenport et al, 1990), since processes cut across various parts of the organization , a process redesign effort driven by a single business function or unit is

highly likely to encounter resistance from other parts of the organization. In his article,"IT-Enabled Business Transformation...", Venkatraman also reinforces the importance of the role of management in a re-engineering effort when he says "Management's challenge is to continually adapt the organizational and technological capabilities to be in dynamic alignment with the chosen business vision" (N. Venkatraman, 1994). Many organizations are enjoying remarkable success because their CEO's have been a driving force in introducing continual changes with IT to improve business efficiency (P. Prairie, 1993). When commitment is from the top, the changes reach all the levels of an organization.

Rapid Development

As previously stated, a key metrics for IS organizations is speed. The concept of rapidly developing applications is not new. While tools and techniques have become somewhat standardized, full adoption has been slow. IS methodologies are often incomplete or inadequate, and application maintenance and development are a continual problem. According to Anderson Consulting, maintaining lines of Cobol code in use in the United States alone accounts for 80 percent of all data processing dollars spent in 1989 (I/S Analyzer, 1990). James Martin states that the average company's application backlog is 61 months, not counting the "hidden" backlog of requests that are never made because of the long lead time. Clearly, new and more efficient applications

must be built to replace old ones and to support new and emerging business functions as well. For this, techniques like Rapid Application Development (RAD) are essential.

Rapid Application Development (RAD) takes maximum advantage of integrated CASE (I-CASE) tools. It can also be implemented with high level languages, GUIs and powerful data base systems without the usage of CASE tools. RAD aims at delivering quality, and by quality it means 'meeting expected customer requirements'. The RAD concept is based on four foundations: (1) the Information Engineering methodology, (2) high quality software engineering tools, (3) using the most highly skilled peopl,e and (4) strong management support. RAD is a departure from the traditional project life cycle. Its methods can speed systems delivery by as much as 1300% (W.B. Foss, 1993). RAD has proven to increase productivity and bring costs down. When an average development cost per Cobol function point is $500 to $1000, average cost per RAD function point is $50 to $100 (W.B. Foss, 1993).

RAD's success depends on companies adopting ideas such as incremental delivery of components of a system, teamwork, achievable goals, and less waste. Incremental delivery of components is the application of a phased approach to the development of a system, so that each phase can be completed in a prioritized order and delivered one-by-one in that order to the customer, each phase being a well-defined, independent portion of the system. Teamwork is the concept of IS personnel, and the business personnel working together in jointly determining the requirements and the design of the system. The concept of teamwork should also be applied to the actual

coding of the application where, the expert developers of the system work together to develop the system instead of the traditional method of dividing the work among each individual. Team work during development can be accomplished best by utilizing RAD tools. Achievable goals, are those that can be accomplished with the given resource capacities. Resource not only involves money but also the skills, available time frame, and realistic technology applications that can be met. Less waste is the utilization of resources in the best manner. Resources should not be waste on non-value added activities and by committing unnecessary expensive mistakes. For this effective planning is essential. RAD is not about fancy tools but about significantly rethinking development methodologies and management techniques ((W.B. Foss, 1993), (D. Baum, 1994)). Table 2 compares RAD with the traditional method of application development, TRAD.

As noted in Table 2, a major difference in the two approaches is the amount of user involvement. Throughout RAD, users play a major role, while in TRAD, they participate primarily at the beginning and end. This involvement is extensive in the joint design phase of RAD.

Joint Application Design (JAD) is a crucial dimension for RAD (D. C. Andrews, 1991). JAD provides a mechanism for managing the politics of a project, increasing user commitment and involvement through consensus building and objective and unbiased leadership. JAD focuses on improving the front-end life cycle deliverables.

Table 2: Comparison of RAD and TRAD Methods

RAD(Rapid Application Development) Interactive Approach	TRAD (Traditional Development) Linear Approach
Information Engineering	Requirements Planning
Systems Analysis	External/Internal Fixed Design
Joint Design	Programming
Interactive Prototyping	Testing
First Release In 3 months	Full Implementation 18 months or longer
Subsequent Releases	

Shaded area indicates heavy user and coder interaction and use of automated development tools.

A study of 60 projects in 1989 by Capers-Jones indicated that those projects that did not use JAD missed up to 35% of the needed functionality, which impacted coding by adding up to 50% more code. In contrast, the projects that utilized JAD missed only 10% of the functionality and only 5% if JAD was combined with prototyping. The actual code impacted was minimal.

JAD builds the positive, non-hostile, team-oriented partnership among systems professionals and users required to develop systems that are integral to strategic and tactical cross-functional business operations at a speed that delivers in six months, not two years or more (D.C. Andrews, 1991). Organizations have reduced their direct

project costs 20% to 30% with its use. JAD has to be integrated with Information Engineering methodology and the CASE tool automation. Since it has direct impact on the operations of project teams, the involvement of users in the projects, the systems development life cycle, and the systems organization culture and politics, a comprehensive approach is needed to ensure its long-term adoption as a way of doing business by the IS organization.

Summary

IS organizations have to optimize the development process in order to help the business organizations meet industrial demands. From this literature review, several issues within the IS development process, have clearly emerged that need to be dealt with effectively. The traditional development process does not fit in the current environment and is not an effective approach for IS organizations. A more effective approach is needed. Such an approach should accommodate organizational requirements. Its implementation should include information planning, Joint Requirements Planning, Joint Application Designs; and it should adopt faster and effective methods and tools. It should be responsive to re-engineering of the business processes and facilitate the alignment of IT with such efforts. To meet these requirements, the development process must be re-engineered to incorporate faster tools, effective concepts, and sound techniques.

Chapter III

METHODOLOGY

Introduction

The review of literature has provided evidence of problems and deficiencies within the traditional development methodology or life-cycle, and established the need to re-engineer this process. This chapter will discuss the approach taken by this thesis in identifying and analyzing deficiencies and problems in the traditional method of system development, choosing significant contributors to the problems and forming an effective solution to them. It will discuss the case study, an IS project to which the new development concepts were applied and validated. It will further discuss and compare its results to two other projects, each developed using different development approaches

Identifying Problems and Deficiencies

The research process started with extensive literature review. From the literature review it was first established that the majority of IS organizations are still following traditional, structured method of systems development. Several problems, deficiencies, and issues have been reported by the IS organizations. Among the most reported causes for failure of IS projects are improper systems analysis; inaccurate requirements definition of the project; creeping scope of the project; lengthy projects; management

failures to support project purpose; lack of a formal structure in approaches; and lack of end-user involvement, communication, and ownership of project. These elements create systems that are not used because of poor end-user satisfaction. The major deficiency of the system development process was identified as the lack of an approach within the development process which involves organizational information planning, proper re-designing of business processes within project scope and effective information technology alignment to them.

There are problems such as a lack of metrics, lack of an understanding of productivity issues in IS organizations, lack of skills in increasing technology productivity, and lack of adoption of software engineering methods in improving quality of software. All these deficiencies are due to lack of identification of the critical success factors of an organization and implementing proper programs through planning to achieve them. These additional problems however are not stated as major factors that affect the IS organization's success. These problems identified above fall into the final phases of a project life-cycle. Problems identified as significant contributors are associated with the initial phases of the system development process. It is not only important but also wise to re-engineer the initial phases first and then move on to the rest of the phases. The significant contributors are related to systems analysis, definition, and design of the information system.

Relationships Among Problems and Deficiencies

As a next step, the problems and deficiencies were analyzed carefully. The question of whether all these problems and deficiencies are related and impact each other or, are unrelated results of separate activities had to be answered. Patterns were recognized within the problems and deficiencies. Figure 6 show problem and cause relationships in detail. They can be simply summarized as follows. Systems analysis (which is done as an initial step) may be improper or inaccurate due to the project being large and lengthy (i.e., scope being very big that analysts may not be able handle it with ease therefore make several mistakes and misjudgments), due to inadequate, incomplete IS and User communication, and due to not understanding the actual goal and objectives of the project from a business process perspective in achieving the business process goal (where the business process is the one for which the information system is built). A project may become lengthy because of requirements creep (i.e., changing user requirements over time), improper definition of project scope, absence of control over boundaries and limitations of a given project, or the project being naturally large. Lack of end-user satisfaction may be due to improper systems analysis leading to not understanding the deliverables of the project and end-user expectations clearly.

Literature review states that most information system tools are not even used by the users and most IS projects are "runaways". There can be two reasons why the users may not use an IS tool. One, might be due to the tool not serving the right purpose for

Lack of customer (end-user, business management) satisfaction may be caused by

- Not delivering expected functions

  may be caused by

  1 improper requirements specifications

  2 inadequate understanding of the business process

  may be caused by

  1 improper systems analysis and business analysis

  may be caused by

  1 inadequate understanding of roles and responsibilities

  2 inadequate expertise

  3 inadequate communication between users and IS personnel

  may be caused by

  inadequate management communication

- Poor system performance

  may be caused by

  1 improper requirements specifications

  2 inadequate expertise in development

  3 improper design of data structures and their processing

  4 poor choice of technology

  may be caused by

  1 improper systems analysis and business analysis

  2 inadequate understanding of data size and traffic

  may be caused by

  inadequate research of business process and its needs

  may be caused by

  inadequate IS personnel and users communication

Figure 6: Problem And Cause Relationships

Lack of customer (end-user, business management) satisfaction may be caused by

- Poor design of the system
  may be caused by
  1 improper requirements specifications
  2 non-involvement of users in the design of the system
  3 not understanding users needs and preferences
  4 not undertanding business process needs
  may be caused by
  1 improper systems analysis and business analysis
  2 inadequate users and IS personnel communication

- Cost and Schedule Overruns
  may be caused by
  1 Large project size
  may be caused by
  improper definition of project scope
  may be caused by
  improper systems analysis
  may be caused by
  1 inadequate research of business process and needs
  2 improper IS and user communication
  2 Incompletion of project
  may be caused by
  requirements creep
  may be caused by
  improper systems analysis
  may be caused by
  inadequate user, IS and management communication

Figure 6 (continued)

the business process. The other might be due to the users not liking the tool and not being comfortable about using it. From these reasoning, two needs can be identified.First a project's purpose has to be clearly understood both by the user and the IS personnel. For this, thorough systems analysis is required. Secondly, for the project not to be a runaway, consensus should be reached among the user and IS personnel on the requirements and scope of the project and the functionality of the 'to-be' developed IS tool. The deficiency of the traditional methodology not involving business process re-engineering and alignment of IT strategies to business process strategies may again contribute to improper systems analysis and requirements definition. An understanding of the existing business process and its systems is necessary to clearly define how the new business process should work and how the new IS tool should be designed to serve its purpose. Thus all the problems and deficiencies are clearly related to each other and impact one another and therefore impact the success of an IS project. Also, all these problems can be identified in the early part of the system development process.

Analyzing Problems to Identify Solution Strategies

The analysis of case studies described in the literature resulted in the development of the following prescriptions:

(1) Well defined boundaries have to be drawn around users' expectations not only of the development process but also of the scope of the new IS application. Where, scope includes scope of the business process for which application is built and the

functions of the application. (2) No more should a systems analyst do his/her job alone. User involvement is a critical success factor. This enunciates the need for improved IS and User communication and therefore demands team work from both groups. These needs lead to the next question of how users and IS personnel can work together in the development process. The development process has to incorporate principles and techniques which increase user participation, involvement, and ownership in the process. Users should provide a business process perspective and IS personnel should provide a system perspective and both perspectives should be clearly understood by both sides. For this, solutions are available in Joint Requirements Planning (JRP) and Joint Application Design (JAD) principles.

(3) JRP and JAD principles should be adopted. This will ensure user involvement, ownership, and commitment to the project can be ensured. This will solve the problem of not reaching user expectations, users' requirements creep and will allow control on the scope of the project. Right through the process, the users are involved and know what to expect. They are allowed to take ownership of the project and express their needs and requirements from the IS tool. Through JAD users are able to take ownership of the application itself and design them to suit their business processes and their comfort.

IS organizations are facing several issues during each phase of the development life cycle of a project. These issues affect the productivity and results of each phase, and hence impact the entire project outcome. IS personnel are mostly not aware of the

several issues which might arise during the life cycle of projects and how to deal with them.

Now, the next question of how to deal with large and lengthy projects has to be answered. Lengthy projects may not be the right way for development processes any more. There is no way that requirements creep can be avoided if the project goes on for a long time. Business processes change very dynamically in proportion to the competition they face. According to those changes, their requirements also change dynamically and dramatically. (4) Projects have to be dealt with and delivered in incremental sizes and components. This ensures faster development life-cycles, manageable project sizes, confinement of requirements, and achievement of user expectations. The more the complexity of the project in hand the more the delivery time, more avenues for committing mistakes.

Problems in current systems analysis approaches have established the need for re-defining systems analysis in a project development life-cycle. Systems analysis is not just about defining and researching existing systems to determine requirements of new systems any more. Systems analysis is more about what the business process is and how systems can be best aligned to them. When systems have to be aligned to the business process, this raises the need for IT strategy planning along with the business strategies. And in order for IT alignment to be in the proper direction and productive, management involvement in information strategy planning is necessary. (5) The whole process of systems development should be management driven, and has to be re-defined

to involve organizational information planning; prioritization of business needs; existing process and systems research; business process redesigns; and alignment of technology to the business processes to produce better, productive, strategic information systems.

Strategic Implementation of Methodology

After the solution strategies were identified, the effort of the thesis was diverted at developing a formal structure and detail to the strategies. Questions such as how systems analysis should be done for contemporary needs, how strategies can be incorporated within the systems analysis and application design effort had to be answered. Two different research approaches were used when forming the solution.

One approach was to find answers from actual experiences described in the literature. Various organizational experiences available from literature were collected and analyzed to develop proper steps for applying each solution strategy and succeeding in it. All the above analyses and determination of solution strategies were formed from the existing literature.

A second research approach was then applied to further confirm the literature results. The second approach was to utilize the experiences of ten project leaders of an MIS organization. This experience was gleaned through discussions at various meetings and during the sessions conducted to develop their in-house system development methodology. Most of the project leaders in the MIS organization had worked in several environments in different organizations, therefore they had a wealth

of experience in system development. This MIS organization will be referred to as belonging to Company A from now on.

Background of MIS Organization in Company A

The MIS organization of company A had decided a year ago before the study began, to replace its mainframe systems with client server technologies. It decided to replace the mainframe systems incrementally. It prioritized the business systems and chose an area for new development. Lets consider this effort as project A. In taking full advantage of the client server technologies MIS decided to use rapid application development tools to expedite the development task of project A in the hope of delivering systems faster by dramatically shortening the development process. Since the new systems were to be developed for an already existing business process, the developers already had a clear understanding of the requirements and functions of the process. Project A was going to be quiet big and complex. Coding was going to be a very big effort. All that they thought they had to do was to go ahead and start the development process, wasting no time, but with some user involvement in the application design. The business was pressurizing them for rapid delivery of the system. They performed a brief investigation of existing data, performed some joint application design, modeled their entity relationship diagrams and started coding the application.

The system was delivered 6 months ago, it has not stabilized and users have constant problems and complaints with its functions and performance. Project A has proven to be a costly mistake. It had all the problems the literature review identified and paid big prices for those problems. Even though company A used Rapid Application Development tools for coding the application, they did not develop a good product because they did not perform proper systems analysis and requirements analysis. They did not consider re-engineering the existing process to improve its strategic role in the business. They did not align the goals of the business process with the goals of the company. They did not investigate the problems with existing information systems. Project A also has proven that just adopting new and efficient tools does not achieve a good development process. Again, it also points out the significance and importance of the initial phases of the development process.

Some time after project A had been implemented, project B started. Project B's development process was different. It had performed Business Process Re-designs, Joint Application Designs, and Rapid Application Development. It used the same development tools as project A. Its size and complexity were considered to be a quarter of that of project B. But, the development process of project B did not have a well defined structure. Every one who worked on the project were new to the concepts. They hadn't performed an organizational strategy planning. Process modeling was considered a success because it achieved an efficient business process redesign. It

helped define the scope of the project. Project B was delivered in time and made a large impact and won a quality award from the top management.

When this study began, the IS personnel in company A had realized the mistakes associated with project A. They had realized project B was a success, but did not think that the entire approach had a formal, well-defined structure or understood by all the project leaders. Still there was a need for analyzing the approaches applied to project A and project B and compile a structured universal methodology which takes into account every aspect necessary for a successful development process. They realized the essentiality of developing and following a strong methodology, but did not think that the traditional waterfall method offered the perfect solution to it. They felt and agreed that traditional method had, all the problems identified by the literature review. Company A was willing to adopt a better methodology with more effective approaches to systems development.

Detailing Solution Strategies

Company A was ready for a new methodology. A new methodology for the entire development process was created with the first two phases formulated from the thesis solution. Ten project team leaders met daily, for twelve days, for four hour sessions to formulate the development methodology. During the initial sessions, solution strategies identified through the literature, were presented to the leaders in the form of a list of phases, their activities, and the individual tasks of a development

process. The solution strategies and the listing matched their needs. This thesis author facilitated these sessions and helped the participants understand the principles and concepts involved in the solution and validated them against the project leaders experiences. A new set of structured ideas relevant to each phase of the development process was presented to the group during each session. Discussion exercises will be conducted on those ideas. An agreed structure will be updated and presented in the next session along with a new set of ideas for another activity or phase of the development process and so on. A process model for the entire development process was also iteratively developed. The process model for the new development process is shown in Figure 7. As a first step to forming the methodology, all the requirements of the initial efforts of planning, project identification, analysis, and application design were considered for re-engineering, since these contribute to a major part of the development process and also have the highest need for re-engineering. These efforts were grouped as the first two major phases of the development process. Next, activities within these two phases were identified. When identifying activities, the problems recognized within the development processes were taken into account and solution strategies identified were applied to every activity in the right order. Experiences from project A and project B were analyzed relevant to the discussions and taken into account. Detail from the literature were also discussed in the sessions. After identifying the essential activities, the essential tasks within each activity were identified. The discussions of

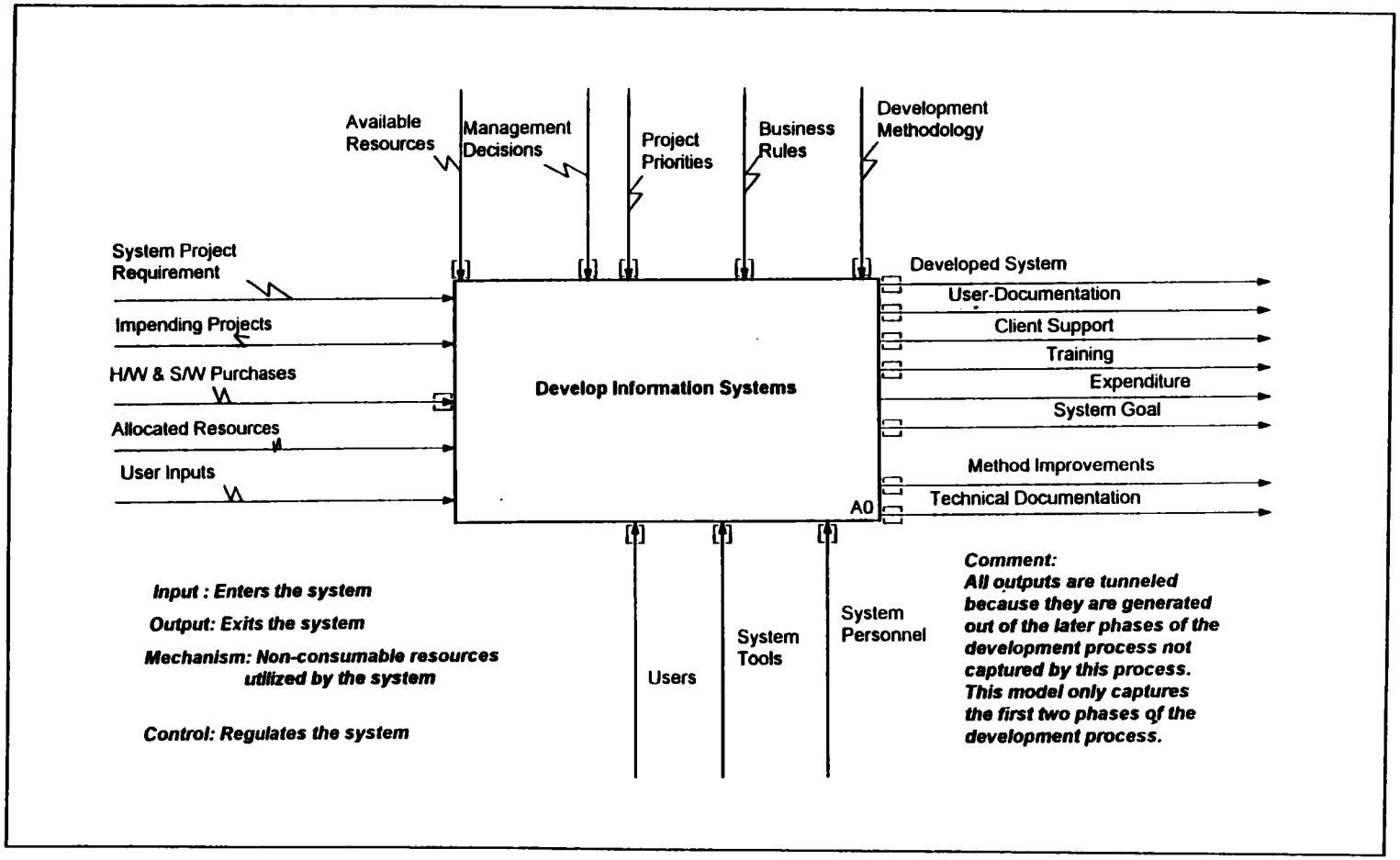


Figure 7: Strategic Development Process Model

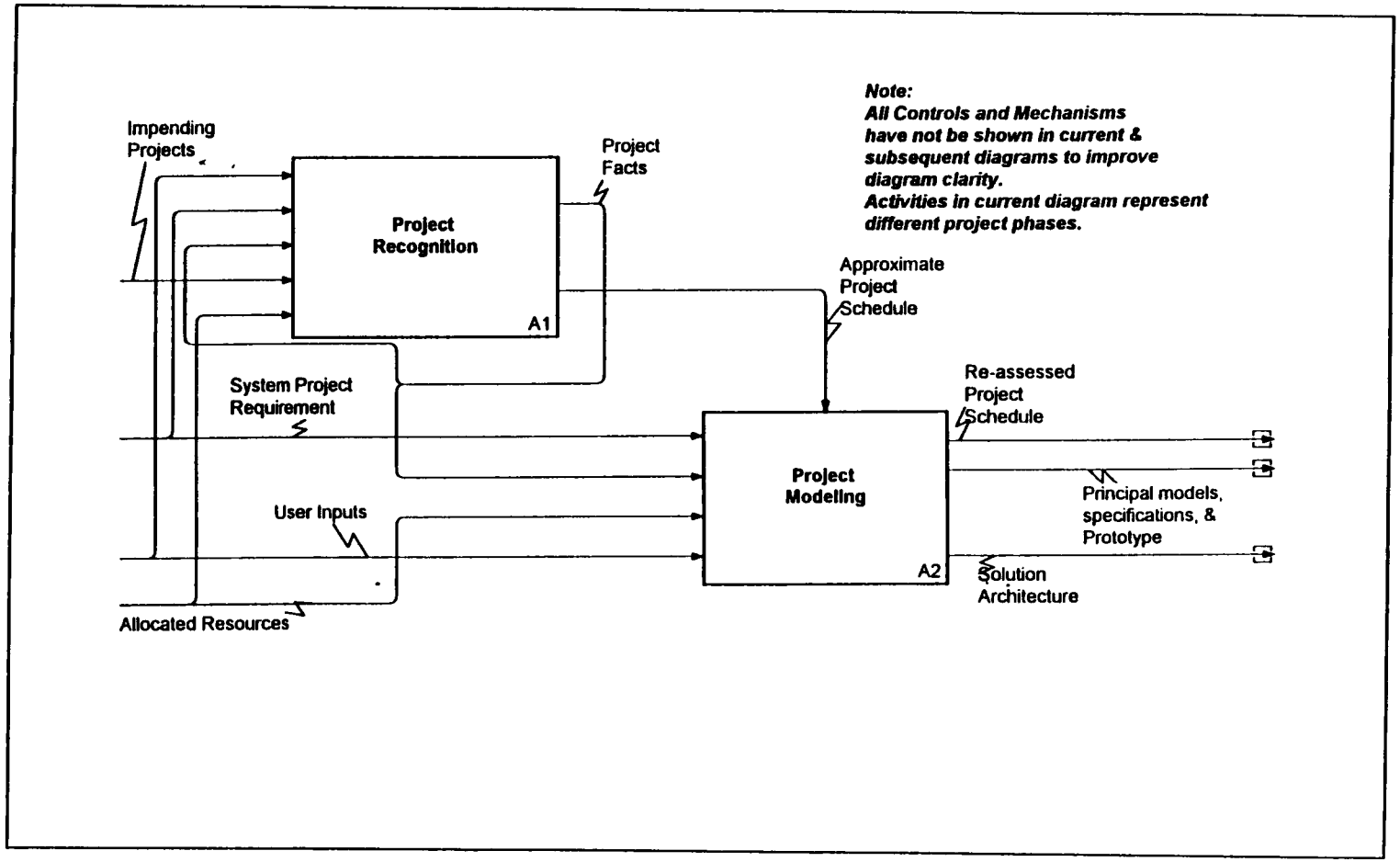


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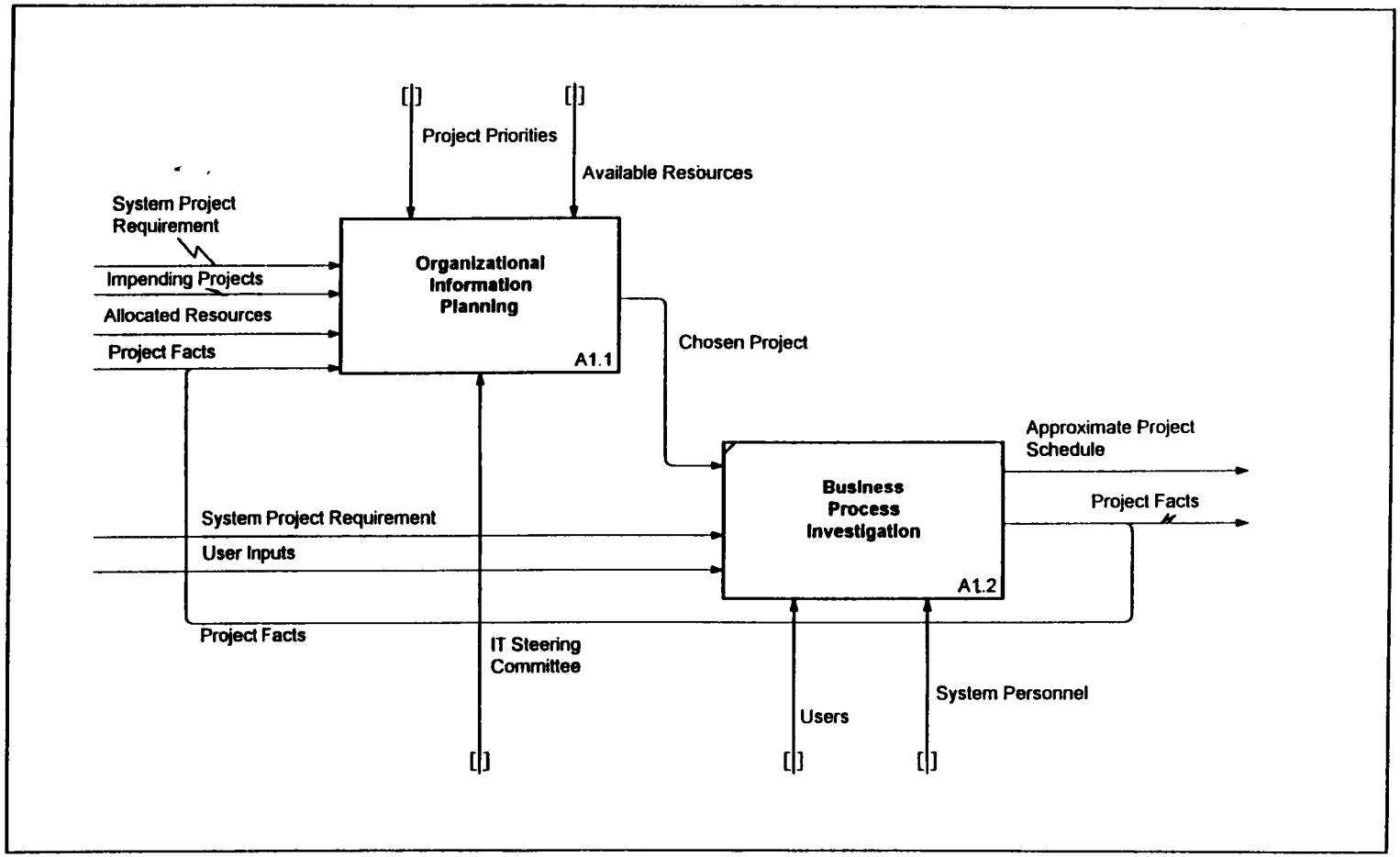


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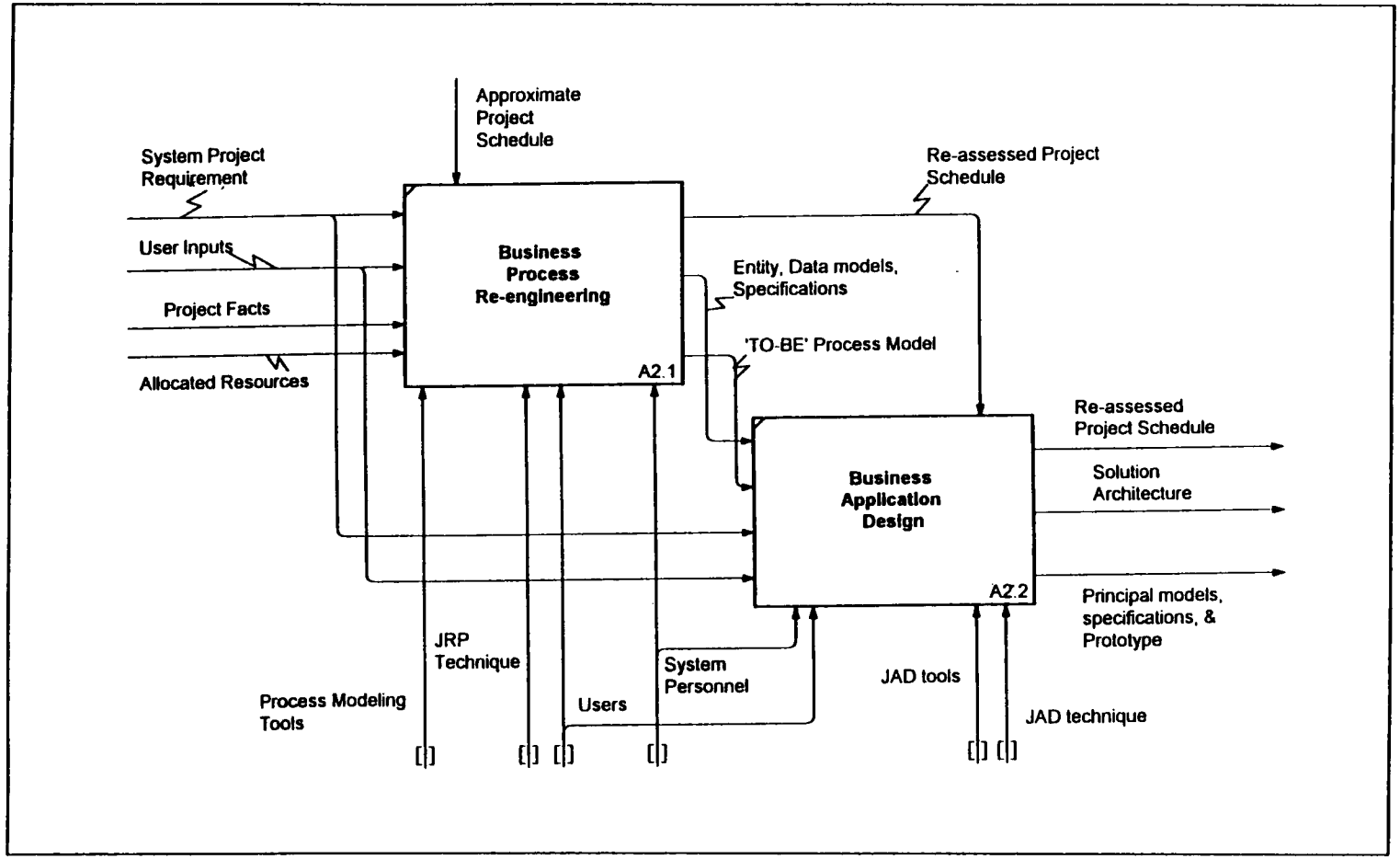


Figure 7: (continued)

these sessions and the detail from the literature were used to compile the solution of this thesis.

Each process or sub-process within the development process seem to be controlled and regulated by a focus, facilitated by certain enabling actions, affected by certain critical factors, using certain mechanisms to accomplish certain objectives. Based on this perspective of each sub-process within the development process, the solution was structured. The project leaders validated the critical factors, tools, enablers, and objectives in the solution from their past and present experiences during every session as the sessions discussed each phase progressively in the right order within the development process. There were no significant changes made to the development and implementation phases of the methodology when compared to the traditional approach. Although, they did not want to consider the development as a life-cycle anymore but as a process which starts and ends when the product is delivered to the IS customer. Any changes to the system were to be considered as an enhancement. Therefore their development process ends after implementation.

Explanation of the Solution Structure

All IS organizations do not have the same environment. The term environment not only includes system architecture, development techniques etc. but also the type of management, type of industry they support, type of project management techniques they use and so on. Therefore, this solution was structured to account for these differences.

Each phase defined was considered as a sub-process within the system development process. As previously stated, a process consumes inputs, utilizes mechanisms, with controls to produce outputs as shown in figure 1. Analogous to that, each sub-process was considered to be a phase consisting of activities which are facilitated and empowered by certain Enablers (Enablers can be actions, techniques, principles, rules etc. which influence and steer the activity in the right direction, in reaching the effective results by adding a significant amount of value to it), affected by various Critical Factors (Critical Factors are those which are significant issues or practices which have a high influence on the results of that activity), utilizing Tool Support as mechanisms (Tool Support are those tools, or tool features that can used effectively and in improving the efficiency of the activity) controlled by the Focus of that activity (Focus is regulation or control applied to the activity) in order to achieve certain Objectives during each activity of the sub-process (Objectives are those that ought to be completed or reached at the end of an activity). This perspective of a phase within system development process model is represented in Figure 8. From this approach to the solution, the definition of Enablers, Tool Support, Focus, Objectives, and Critical Factors were also formed. Organizations should be able to utilize this solution structure and incorporate their particular values for these elements into their development process, or any other processes related to it.

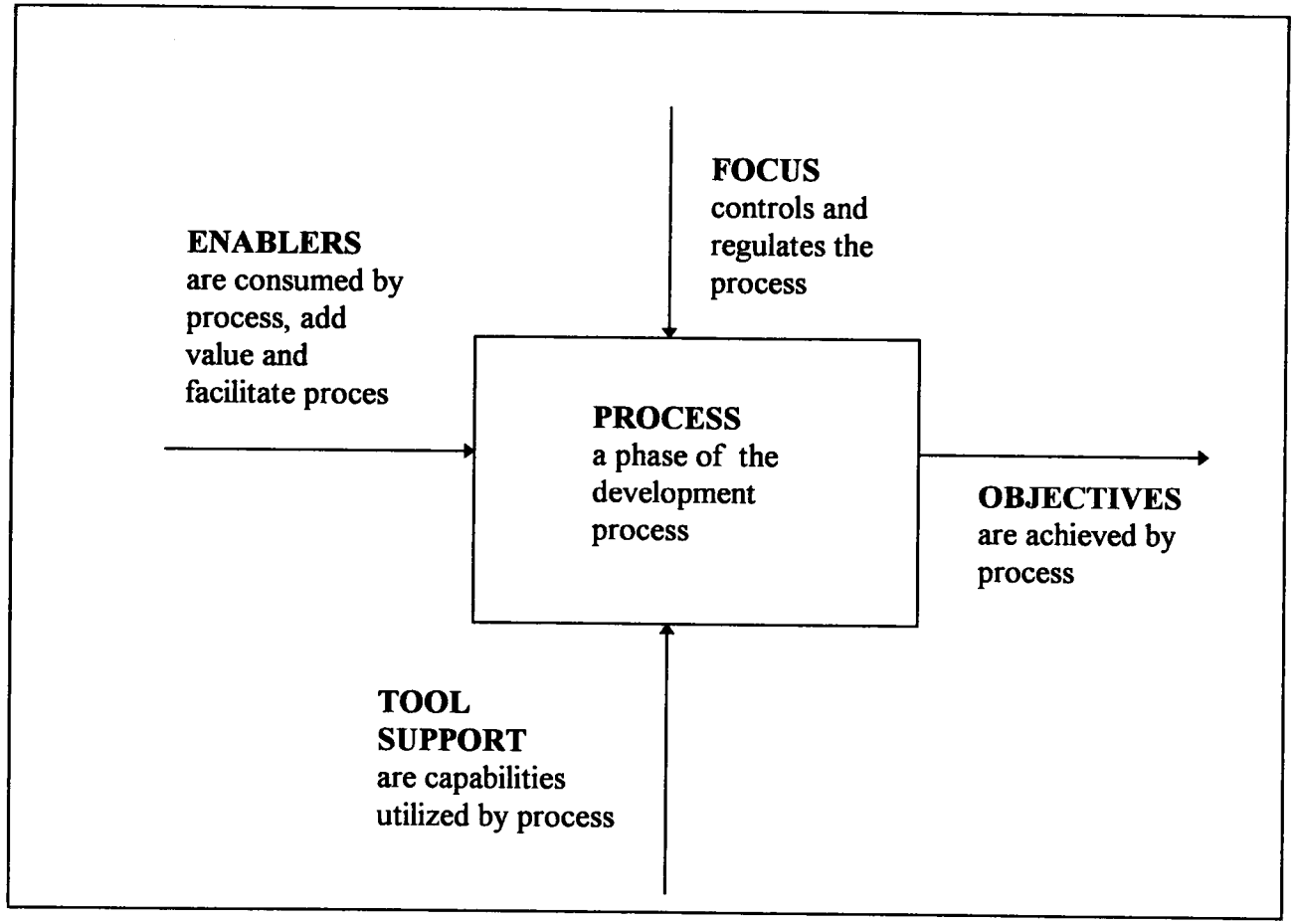


Figure 8: A Strategic Process Model

Case Study

The validity of the solution derived by this study was tested in a real life situation. The purpose of this validation was to confirm the applicability of this methodology and to confirm benefits derived from its application. Specifically the following questions were sought. (1) Will this methodology satisfy contemporary needs of an IS organization ? (2) will it strengthen the analysis and design phases and (3) how much of the effectiveness, quality, and speed of the development process will be increased had to be answered. The next project conducted by company A was used as a case study for validating this new methodology.

Preparation for Case Study

Once the methodology was formulated it had to be adopted throughout the organization. An organizational IT steering group was formed for the business area this MIS organization supports. This steering group consisted of a representation from each of the business groups in this business area. Presentations of the methodology were made to these business groups to educate them about the methodology and its goals, and to get a commitment to adhere to the methodology. This commitment is crucial because, through the new concepts IS customers will begin to play larger roles in the development process. Project C was chosen to test the methodology and its principles

and was chosen as a case study. This project was just beginning as the methodology was evolving. Thus, it was an ideal candidate.

Case Study Measurement

The new methodology was applied to project C. In order to determine if the new methodology provided improvement in the development process, measurements were taken for the following performance characteristics: effectiveness, quality, and speed. These three measures were identified in the literature review as the most critical indicators of success, particularly of the analysis and design phases. Project A, B, and C were compared to each other based on the values of these measurements. Based on the definitions as given in chapter 1, the criteria of measurement for each were established. The criteria were qualitative; however, some not easily quantified. The projects were measured overall relative to each other. Then, each criteria was measured based on certain factors that would affect its measurement. The factors were identified through interviews of the project leaders. The project leaders also identified another characteristic which had an impact on performance, magnitude. They felt the size and degree of complexity should be included.

All three projects were measured against each other based on those criteria and the factors. The measures for each factor were qualitatively defined as being very low, low, medium, high, very high and not performed (when a particular activity was not performed, and therefore criteria was not valid). These measures were assigned a value

of 0, 1, 2, 3, 4, 5 respectively. Each factor and its measure contributed to the value or measure of the criteria. Once the value of the criteria was measured, the corresponding measurement of magnitude, effectiveness, quality, or speed was evaluated from them. The project leaders assigned a measure for each criteria and then explained why the criteria was assigned that measure by identifying the factors that contributed to it. Thus each factor had a measure which attributed to the overall measure of the criteria.

The maximum value a factor can be assigned is 5. The value of the actual measurement for each criteria is the sum of all the values that each factor is assigned divided by the product of number of factors for that measurement and 5.

Results of Case Study

Table 3 shows qualitative project evaluations for magnitude, effectiveness, quality, and speed; criteria for each of them, and the factors for each criteria for projects A, B, and C. Table 4 shows performance measures calculated for each criteria and the percentage performance of each measure for the projects A, B, and C.

Discussion of Results

Project A was the development of a decision support system. The complexity of its functions were very high. There was no business process re-engineering performed, so that application was built for already existing business processes. The old system on the mainframe was partially replaced in the client/server environment through this

Table 3: Project Evaluations

PROJECT EVALUATIONS						
	METRIC	CRITERIA	FACTORS		PROJECTS	
				A	B	C
1	MAGNITUDE	*Size*		***M***	***M***	***L***
			No. of users	L	M	L
			Amount of code	M	M	L
2		*Complexity*		***VH***	***M***	***M***
			Logic	VH	M	M
			Amount of data processing	VH	H	H
			Application designed based on old, existing systems	VH	N	H
1	EFFECTIVENESS	*Business Process Re-design*		***NP***	***H***	***M***
			Experience in BPR	VL	H	M
			Knowledge of BPR	VL	H	M
			Level of control built within the process	VL	H	M
2		*Technology alignment to process*		***M***	***VH***	***H***
			Graphical User Interfaces	VH	VH	VH
			Gathering from multiple systems	VH	H	H
			Updating data over multiple systems	VH	N	H
			Analysis of dataflow and relationships	VL	VH	M
			Reliability in performance of technology	L	VH	VH
			Usage of JRP techniques	VL	VH	VH
			Usage of JAD techniques	H	VH	VH
3		*IT and Business strategy alignment*		***H***	***H***	***VH***
			Phased approach	H	H	VH
			Prioritization of business processes	H	H	VH
			Proper planning	H	H	VH
4		*Business process needs met*		***H***	***H***	***VH***
			Replacement of existing system functions	VH	VL	N
			Analysis of additional functions for application	M	H	VH
			Amount of user expectations met	VL	H	VH
5		*Business productivity improvement*		***M***	***H***	***VH***
			Ability to perform new tasks	M	H	VH
			Provision of good graphical user interface	VH	VH	VH
			Problems due to dependencies on other systems	VH	N	N
			Problems due to cumbersome reporting	VH	N	N

Table 3: (continued)

	PROJECT EVALUATIONS					
	METRIC	CRITERIA	FACTORS	PROJECTS		
	EFFECTIVENESS			A	B	C
6		*Technology productivity*		***H***	***H***	***VH***
			Ability to access multiple systems	VH	H	VH
			Expertise in using new technology	M	H	VH
			Rapid development	H	VH	VH
			Productivity of MIS and User	VH	VH	VH
7		*Attainment of business goals due to IS tool*		***L***	***H***	***H***
			Functionality and design required by the business process	VH	VH	VH
			System Performance	L	VH	VH
			Achieving MIS goal for project	VL	VH	VH
	QUALITY					
		User's functional requirements satisfaction		***VL***	***H***	***VH***
1			Management of users'expectations	VL	H	VH
			Amount of users' expectations met	VL	H	VH
		User's comfort with design		***H***	***H***	***VH***
2			Graphical User Interfaces	H	H	VH
			Users having more control over functions within tool	H	H	VH
			Users' involvement in design	H	H	VH
			Ease of users' learning the tool	H	H	VH
		User's personal productivity increase		***VL***	***M***	***VH***
3			Performance of application	L	VH	VH
			Users' learning curve	H	L	VH
	SPEED					
		Organizational Information Planning		**M**	***H***	***VH***
1			Business Process Investigation	L	H	VH
			Time Spent	VH	M	L
			Effectiveness	VL	H	VH
		Business Process Re-engineering		**NP**	**H**	**VH**
2			Time Spent		M	L
			Effectiveness		H	VH
		Business Application Design		**VH**	**H**	**VH**
3			Time Spent	VH	M	L
			Effectiveness	VH	H	VH
	VL:VeryLow; L:Low; M:Medium; H:High; VH:VeryHigh; NP:Not Performed; N:None Scores Assigned: NP/N=0;VL=1;L=2;M=3;H=4;VH=5;					

Table 4: Project Performance Measurement

PERFORMANCE MEASUREMENT				
METRIC	CRITERIA	PROJECTS		
		A	B	C
MAGNITUDE	*Size*	3	3	2
	Complexity	5	3	3
	TOTAL %	80	60	50
EFFECTIVENESS	*Business Process Re-design*	0	4	3
	Technology alignment to process	3	5	4
	IT and Business strategy alignment	4	4	5
	Business process needs met	4	4	5
	Business productivity improvement	3	4	5
	Technology productivity	4	4	5
	Attainment of business goals due to IS tool	2	4	4
	TOTAL %	57	83	89
QUALITY	*User's functional requirements satisfaction*	1	4	5
	User's comfort with design	4	4	5
	User's personal productivity increase	1	3	5
	TOTAL %	40	73	100
SPEED	*Organizational Information Planning*	3	4	5
	Business Process Re-engineering	0	4	5
	Business Application Design	5	4	5
	TOTAL %	53	80	100

application. Prototyping was performed through Joint Application Design. Rapid Application Development techniques such as JRP, JAD ; tools such as Bpwin, visual basic, C , Perl, and Oracle were used for development of the application. The application was developed under the client/server environment using Unix as the operating system.

Systems analysis, data analysis, and data relationship modeling were done very poorly. The design of data exchange process between the mainframe and the client/server environment was not done effectively. There were several application logic errors. System performance was low. As a result, the users were not satisfied.

They did not get what they expected out of the project. They liked the new graphical user interfaces compared to the traditional screens and were comfortable with the screen design. Overall effectiveness and quality were diminished, however. Primarily, this was because of the poor management of user-expectations. This resulted in poor systems analysis and requirements analysis. During the systems analysis, there was no application of business process redesigns. Thus, no research was performed with existing processes to determine how well they were meeting the users needs. The inadequate analysis resulted in designs which had major flaws. Some of these flaws included insufficient data exchange because of poor design of data exchange between the mainframe and client server, several application performance failures due to logical errors, and speed of the performance greatly encumbered. Also, because no proper analysis was performed so that some of the complexities could have been designed out.

Project B was a transaction based system. It was deliberately structured to be a medium-sized project, and it was a success. It won the quality award for the year. Project B was planned very well from inception. Each phase was on schedule. Business processes were analyzed, current systems were researched, with needs clearly identified. Joint Requirements Planning was done. Business process re-engineering was performed efficiently. Because management of that business process realized the importance, significance and possible benefits of applying BPR within the development process. Through discussion exercises, process models were completed. Process models were limited to the scope for which a system can be developed in the given time frame. Consensus was reached among the team members about the scope of the process model and the project scope. Joint application design was performed to build the prototype and confirm the deliverables of the project. Users were happy with the finished product, although they were not very literate in the new design of the system with GUI. The business process productivity has improved, and the information is considered to be a contributor to that improvement.

Project B was an improvement over project A. But the development process was conducted by a consulting company. The method in which they performed did not suit company A in many ways. There was no organizational information planning conducted in choosing project B. There was no overall strategy for IT projects in company A. Project B was a test project for process modeling, rapid application development, and operations in the client/server environment. Project B also faced a lot

of management resistance. The business process management did not initially understand the significance and benefits of BPR, and the consulting group did not educate them in order to get buy-in. Many elements such as preliminary research of the business process before BPR were not performed. Company A needed a formal structure that could be followed by its employees. It needed formal ways of documenting requirements, specifications, models, and the solution architecture of the project. It needed to understand the principles of the new approaches and apply it to its environment. It needed a cook book approach for development. It needed management support and user buy-in, and it needed a mechanism through which all involved could be educated.

Thus when project C started it was begun with the objectives of meeting all these needs. In fact it was a low-sized project intentionally. It was completed ahead of schedule, it met users' needs and the IS organization was able to do it themselves. They rigidly followed the developed methodology, and all parties (users, managers, and IS personnel) worked together as a team to complete the project successfully.

Project C was planned using 1995 and 1996 business strategies. The project goal was to provide orders information to the factory so that they could utilize the information to maximize the utilization of flexibility in the factory schedules, and thereby increase the direct shipments from the factory. The direct shipments will save a lot of resources spent in storing inventory in the warehouses or moving between warehouses. Thus the IT strategy of developing an IS application which will provide

orders visibility to the factory as a decision support tool was matched with the business strategy.

The current business process which processes orders information was investigated. The business process was re-engineered, and process models were completed. JRP and JAD techniques were applied. The scope of the project was determined, and a prototype was completed. Rapid development was done in a few weeks. The project completion schedule is shown in Figure 9. The process models and other documentation developed during phase 2 for project C are shown in Appendix A.

The level of expertise in applying the concepts of the methodology was high among all the project members. Therefore, the application was developed well ahead of schedule. Users were happy about owning the project. They were proud to re-engineer their processes as they felt, best, and happily participated in the meetings to jointly determine the requirements and design of the application. They were pleased about the rapid project completion and the delivery of the application. The completion time that for the same project to be delivered would be 3-4 months with the previous techniques; but with the new methodology, the application was delivered in one and a half months time.

The underlying business processes were not dramatically re-engineered because of the lack of knowledge of BPR principles among the people involved in the project. This affected the effectiveness of the project to some extent. If the business processes had been re-engineered radically, then dramatic improvements may have been realized.

[1]Day Completed	[2]Tasks
1	Management Visioning; Fact sheet completion;
2	Wrong process was modeled
3	As-Is completed, To-Be started; As-Is documentation complete;
4	Users discussion (Supply Manager & Production Planning Manager), process agreement and process expectations complete, AS-IS consensus; Documentation of application and process specific requirements of users;
5	To-Be complete;Consensus on To-Be with factory1, consensus on requirements; group conference with factory 2 update of requirements;
10	Data model design; Prototype and most functions completion; To-Be improvement; Update of application and process specific requirements; Documentation of To-Be;
11	Prototype presentation, consensus on To-Be with factory schedulers;
16	Development complete, presentation to supply manager; update of application specific requirements; Documentation and correction of To-Be;
17	Presentation at factory, research on h/w & n/w requirements for all users; Research on training requirements;
18	Presentation to manager of factory 2, members of factory 1, members of other MIS team; Update of minor changes in display requirements;
22	Changes complete; Planning for deployment;

Figure 9: Project 'C' Completion Schedule

[1] May not imply in all instances that entire day was spent on task
[2] Each task was complete sequentially as listed

But the management has realized this missing element and is proposing to perform some re-engineering once the application has been stabilized in usage. After a given time users of the application will start thinking about how differently and how best they can use the application, and this hopefully will initiate further re-engineering efforts.

Even though the process was not re-engineered dramatically, the project was on schedule, its goal was accomplished and the users got what they expected. The users satisfaction was maximum. Table 5 shows a summary of the results of measuring project A, B, and C based on the four criteria. One can see from the table that project B was an improvement on project A. And project C was an improvement both on project B and project C. As the magnitude of the projects reduced, the quality, effectiveness, and speed improved. The speed of delivery also improved as the expertise in applying the concepts and discipline toward following the methodology increased.

Table 5: Summary of Project A, B, and C

Project	A	B	C
Magnitude	80%	60%	50%
Effectiveness	57%	83%	89%
Quality	40%	73%	100%
Speed	53%	80%	100%

Figure 10 is a graphical representation of the comparison of performances of the three projects (It should be noted here that no weights were placed on the criteria.).

Summary

The new methodology has proven to provide a structure for a rapidly performing the development process to create a high quality system which is highly effective. Project C, the actual case study for the methodology has been deemed a success. It has produced 89% effectiveness, 100% quality, and 100% speed for a small-sized project. The solution structure of this thesis has provided the basis for this methodology. This shows that the solution is indeed valid and does improve the performance of the development process.

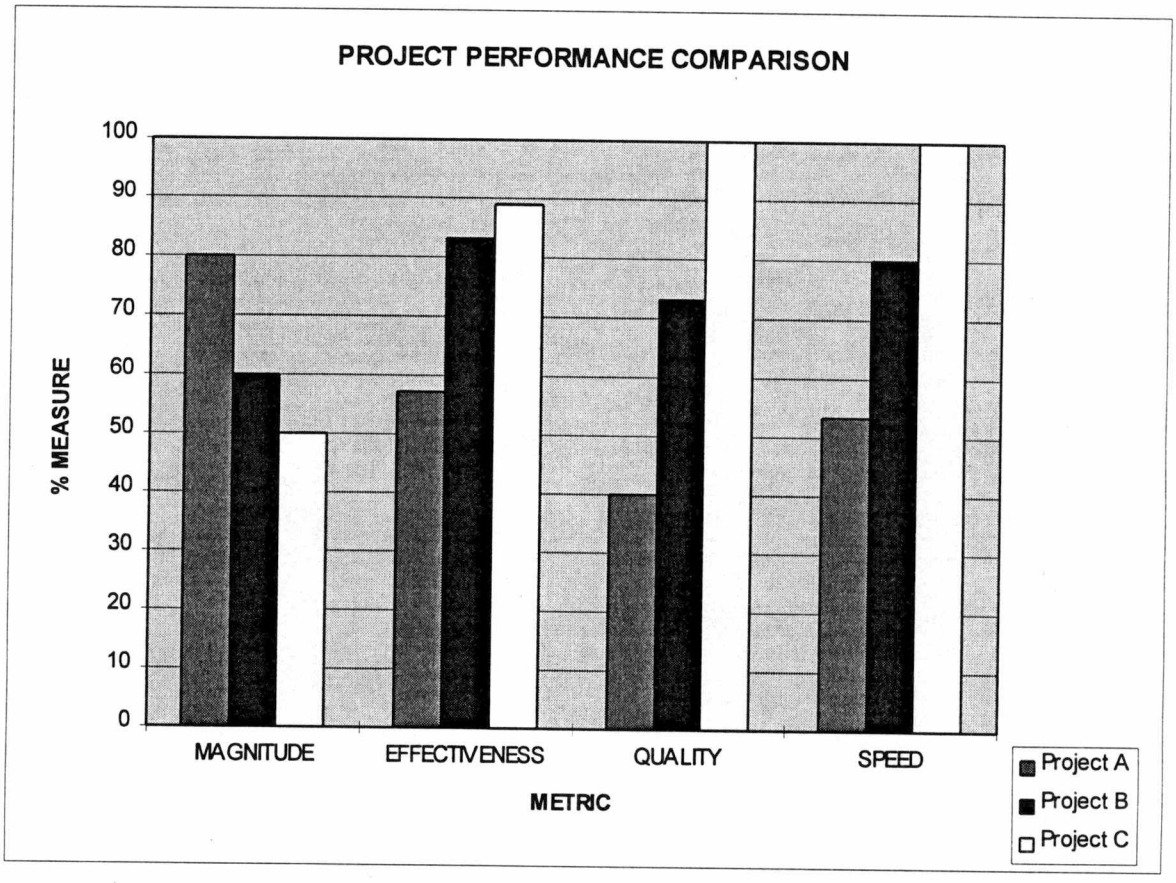


Figure 10: Graphical Representation of Performances of Projects A, B, and C

Chapter IV

SOLUTION AND DISCUSSION

Introduction

A proper solution structure has been formed for the problem. This chapter will provide the solution structure and discuss it thoroughly.

Solution

The solution and its detail are shown in Table 6a, 6b, 6c, and 6d. A summary of various role players and their responsibilities within the first two phases of the strategic system development process is presented in Table 7.

Discussion of Solution

The first two phases of a system development process should be Project Recognition, and Project Modeling. During Project Recognition, two major activities should be completed. Those are Organizational Information Planning and Business Process Investigation. The main goal of Project Recognition is to identify the most viable process for an IS project development and investigate its needs so that it may be improved to meet the business goals effectively.

Table 6: Strategic System Development Process

Phase 1 - Project Recognition		
Activity 1 - Organizational Information Planning		
Focus		
Addressing competitive needs of industry		
Planning business and information strategies		
Organizational information modeling		
Objectives		
Identification of organizational goal, objectives, obstacles, and critical success factors		
Prioritization of improvement of business processes based on above		
Utilizing an organizational process model to envision ideal process structures		
Developing vision for organizational information and formation of enterprise-wide information model		
Prioritization of information needs and systems projects with that of the business		
Enablers	**Critical Factors**	**Tool Support**
Forming a corporate IT-steering group in the organization	Functional separation of information flow	Information modeling
Committing to a long term Re-engineering Effort	within organization	Project Management
Adopting a system development methodology	Lack of organizational vision at any or all levels	Decision Support
Driving goals and objectives through all levels of organizatio	Lack of understanding significance and	
Driving support for IT applications from Top Management	importance of IT in business processes	
Maintaining competitive awareness of IT trends	Lack of separation of business processes and	
in other organizations	technology	
Continuing awareness of IT significance	Lack of competitive awareness of best IT practices	
in business processes	Lack of proper prioritization of business objectives	
Selecting critical processes to re-engineer		
Identifying additional value-added processes related to		
the critical processes		

Table 6: (continued)

Phase 1 - Project Recognition		
Activity 2 - Business Process Investigation		
Focus		
Business processes and Productivity needs		
Benefits of Information Technology		
Justification of investment in Information Technology		
Objectives		
Research of business process assigned for project		
Identification of project goal, objectives, benefits, impacts, dependencies, priorities		
Analysing worth of resources investment in project		
Complete project facts in a document		
Enablers	**Critical Factors**	**Tool Support**
Proper interviews of users, business managers,	Differences in business practices among users	Documentation and Requirements
business functional representatives	Mis-communication between users and the managers	specifications software
Understanding business area goals & objectives	Absence of a formal structure to the business process	CASE tools
Understanding changes needed for		
current environment		
Presence of well-structured and well-defined		
business processes		

Table 6: (continued)

Phase 2 - Project Modeling		
Activity 1 - Business Process Re-engineering		
Focus		
Process tuning through re-engineering		
Precise definiton of IS project scope and boundaries		
Objectives		
Joint Requirements Planning by users, business process managers and systems personnel		
Re-engineering existing processes to ideally functional processes;		
Completion of 'as-is' and 'to-be' business process model; Update organizational process model;		
Identifying and establishing business rules		
Development/Identification within an enterprise wide information model; Data model formation		
Re-Definiton of project scope ; Reducing project complexity by sizing down to simpler sub-projects		
Identification of possible technology applications		
Documenting workshop proceedings and outcomes		
Enablers	**Critical Factors**	**Tool Support**
Understanding view-point of business process	Lack of consistent practices of business	Strong Graphical User Interfaces
and its customers; Making changes for customers	processes among users or managers	Project Planning Functions
Maintaining view-point & purpose of process re-design	Lack of adequate user representation	Organizational Analysis
Developing customer-oriented process	Lack of systems knowledge in users	Process Modeling
model of the organization	and business managers; Lack of	Activity Based Costing
Integrating group dynamics techniques within JRP	business knowledge in IS personnel	Budget Analysis
Applying a step-by-step approach to process modeling	Lack of leadership, ownership,	Time and Resource Analysis
Performing Activity Based Costing in	and committment to project	Capture Of Business Logic
linking activities to resources	Lack of team work among business	Benchmark Analysis
Benchmarking performance and performance drivers	representatives and IS personnel	What-If Analysis
Graphical Simulation Modeling Of Process	Lack of knowledge of organizational goals	Linkage to application
Business Metrics Definition and Usage	and objectives among persons involved	development tools
Process policies and procedures identification	Lack of detailed communication	
Applying proper technology;Concurrence on IS project	Lack of skills in performing business	
scope for boundaries and functionality	process re-designs	

Table 6: (continued)

Phase 2 - Project Modeling		
Activity 2 - Business Application Design		
Focus		
Complete identification of requirements and functional detail for new information system		
Actual system design through prototyping		
Clear definition of system scope		
Objectives		
Joint Application Design by users, business and systems representatives		
Designing standardized dialogs, screens, and interfaces for application		
Determining functional specifications for system		
Determining security measures for new system		
More detailed entity and data models		
Developing Application Prototype and confirming project deliverables		
Identification of all users of the system		
Determination of resource requirements for development and deployment;		
Complete soltution architecture with process models, data models, user functional specifications, prototype and resource requirements;		
Enablers	**Tool Support**	**Critical Factors**
Ensure that users correctly specify requirements	Entity Relationship Modeling Tool	Poor, Incorrect, Incomplete requirements
Sharing business vision among users and developer	A visual language	New technology unfamiliar to users
End-user designing the application	Project Management	Long projects whose requirements change even
Including user participation and	Monitoring Tools	while project is in the development stage
ownership of application	Accurate specification	Failure to manage user expectations
Integrating group dynamics techniques within JAD	requirements documenting tool	Failure to involve users in early stages
Prioritizing project based on business requirements	Prototyping tool	Failure to employ prototyping or JAD techniques
Achieving consensus with discussion exercises	CASE Tools	Writing ambiguous system specifications
Timely identification and resolution of issues	I-CASE Tools	Poor communication
Prioritization of requirements by planning for		
incremental delivery		

Table 7: A Summary of Roles and Responsibilities within Strategic System Development Process

	Role Players				
Phase	**IT Steering Committee**	**Business Managers**	**Users**	**System Personnel**	**Top Management**
Project Recognition	-Define the business vision -Communicate vision to all levels within organization -Align goals and objectives to overall enterprise goals -Plan Information strategies -Prioritize Information needs -Weigh all factors and alternatives -Choose value-added processes -Choose feasible and realistic system projects	Communicate, -information needs -resource availabilities -existing system effectiveness -existing system inadequacies -current process performance -business rules -business function detail -business function purposes	Communicate, -system usability -every day productivity -every day problems -information needs -system expectations -business process defects -business process detail	Communicate, -current projects' status -current system activities -priorities -resource availabilities & requirements -feasible future projects -IT benefits in business processes -IT capabilities & potential -feasible IT solutions -project goal, objectives, benefits, impacts, & requirements	Communicate, Enterprise goals, objectives, vision to all levels of the enterprise
Project Modeling *JRP Session*	-Allocate resources to activities -Evaluate project(s) progress -Align project scope with resource availabilities -Prioritize project activities along with business priorities	Communicate clearly, -Current business process detai -Current business rules -Desired ideal process functions -Business process objectives -Collaborate with MIS team in designing ideal 'TO-BE' processes -Define an easy to reach process scope for system development to fit the available resources -Communicate required functional capabilities of system	Communicate clearly, -Every day process detail -Every day information processing issues, needs -Current system defiencies -Current system efficiencies	-Collaborate with users and business representatives in identifying information needs -Facilitate development of an ideal 'TO-BE' process model for the business to reach the objectives -Recommend processes with potential for IT applications -Recommend easy to reach process scope for which a system may be delivered in a given resource frame	
JAD Session	-Allocate resources to activities -Evaluate project(s) progress -Align project scope with resource availabilities -Prioritize project activities along with business priorities	-Communicate additional business rules, functions, tasks, information requirements -Finalise system design with protoype -Prioritize system components to meet business priorities and plan incremental delivery	-Communicate desired features in application, format for information inputs, outputs, access, organization, display	-Recommend screen formats, , application features -Recommend comfortable features by taking the type of users into consideration -Educate users in translating their needs to requirements	

Organizational Information Planning

Organizational Information Planning focuses on addressing competitive needs of the company by planning appropriate business and information strategies. This phase should be entirely management driven. The level of management should be suitably determined by the organization for appropriate situations. The management should define its business goals and objectives for a given period in the future. Then it should clearly identify and define its business strategies which would help accomplish the goals and objectives. A business strategy is a way of performing the business that would position the company in an advantage over its rivals. According to its business strategies, the company has to identify needs and avenues for improvements which through technological innovations will increase the strategic advantage and positioning of the company. Once these needs and avenues are defined, the company will be able to identify the business processes which have the potential to fulfill them and facilitate the realization of the expected strategic advantages.

Business processes which directly add-value to the company's competitive needs should be prioritized according to the achievement and improvement needs of the company. Once the business processes are prioritized, technology should be aligned to the most value-adding processes. Technology, when aligned effectively can produce very high value within a process by increasing its efficiency. But technology should be aligned properly, for it to be entirely effective. A technology is effective and properly aligned only when its implementation is planned to suit and benefit the strategy of the

business process. For technology to be effective, the underlying business process should be clearly understood. This need can be met by performing the next activity of Business Process Investigation.

During Organizational Information Planning three types of tools will be very helpful. First, a tool which provides the ability to visualize, update, or create an organizational information model. Second, a good project management tool which will help in identifying potential projects, current project status's, resource availability, expenditures, potential projects and so on, and Third, a decision support tool which will help in planning strategies for the business.

For this activity to be a success certain empowering and facilitating Enablers should be taken advantage of. Establishing a corporate information technology steering group will help in having a focus, direction, and regulation in positioning the organization in a strategic advantage in taking advantage of the power of technology. The organization should commit to a long-term business process re-engineering effort and expect to practice it like a total quality management effort through the life of an organization. A strong and sound system development methodology should be designed for the MIS organization and followed with discipline. This effort should be completely supported by top management. This not only steers the MIS organization in a proper manner and direction but also will help measure and monitor the project development processes for identifying progress improvement needs and establishing organizational metrics programs.

The goals and objectives of the company should be driven by the management through all the levels of the organization and every employee and business process should work toward achieving them. This ensures commitment to the organization's purpose. Top management should be very supportive of information technology improvements and applications. Without the vision, drive, and encouragement from the CEO and CIO of the company, information technology adoption and implementations will not be entirely successful, and are bound to fail. This is due not only to IT implementations needing a significant amount of resource commitment, but also IT implementations needing commitment of usage and open-minded adoption from all the employees. For IT implementations to be successful, management should aware of different IT trends in other organizations who have been successful in taking advantage of its power and also apply it within its organization by understanding its significance in the business process it is applied for. And when business processes are prioritized, they should be selected based on their critical role in the organization and also based on the value a business process and its related processes contribute to the organization's success.

Technology planning should be management driven and including it within the development process adds a new perspective to the development process itself. Thus one can realize that the development process is itself a business process belonging to the organization. This view point is lacking in the traditional methodology where an MIS development process is seen as internal to the MIS organization and its role not

identified with the overall organization it is actually supporting, the effect of which is the development of stand alone information systems (found in current situations), which are not totally aligned to the business processes in achieving organization goals.

Business Process Investigation

This activity focuses on understanding the business process and its productivity needs. It should also focus on investigating the benefits that the business process can derive with technology alignment and therefore justify the investment to be made in the technology. During Business Process Investigation, a detailed understanding of the correct, underlying business process, its environment, its existing technologies and systems should be achieved. Users, Business Managers, and Other Business Representatives who are directly or indirectly related to the conduct of the business process should be interviewed thoroughly. Collection of any reports, samples of application screens, screen menus, functional detail that might be within the existing system application should be completed.

Interviews should be targeted to achieve an understanding of the how the business processes work, what their current purposes are, what the current deficiencies are in the process as well as the associated systems, what issues the users face with current systems, and what they would like to get out of a new information system. A business process modeling facilitator and a systems expert/project leader should

perform these activities. From these detail a fundamental process understanding and project purpose understanding should be derived.

Using the detail, the goal of the IS project, its objectives, sub-objectives if any should be defined clearly. A very general feasibility analysis of the project can be done by identifying benefits that can obtained through the effort of developing an information system for the business process. Any kind of information dependencies on other processes, or data dependencies on other systems, the impacts that the new project might have on other business processes or systems should be also clearly identified and the issues associated with them clarified. A detailed feasibility analysis or resources analysis cannot be done at this point because the scope of the business process for which the system is to be built or the scope of the IS project itself is still unknown.

The need for thorough feasibility analysis even before the project is thoroughly understood is a big draw back of the traditional methodology and that draw back has been eliminated here. During this activity a good documentation and requirements specifications software should be used to document interview outcomes. CASE tools can also be used during this phase for documenting needs and modeling.

The most enabling actions which can facilitate the direction of this activity are proper and thorough interviews. Interviews are very important because they facilitate direct user and IS personnel interaction. Direct interviews are the most effective methods of identifying the facts of a business process and its environment. The presence of a well-defined process structure to the business process will be a great

benefit for the better understanding of the purpose and structure of the business process. If different users have different practices and ways of performing the same business process, it will complicate the modeling of an existing process model in the next phase. The complication might occur due to members of the process modeling sessions not being able to reach consensus on different issues to construct an 'as-is' process model because of the absence of a single way of performing the business process. Early detection of these situations will help in preparing for the next phase. Understanding the goals and objectives pertaining to the business area and understanding the changes needed for the current environment are the most important benefits that should be achieved during this activity. At the end of this activity a process modeling team should be selected with adequate user, business management, and IS representation.

Now, that there has been detailed investigation on the project purpose and the underlying business process the next phase of Project Modeling has to be performed. The first activity of this phase is Business Process Re-engineering.

Business Process Re-engineering

The main goal of this activity is to develop an improved, dramatically, and radically re-engineered business process model of the existing business process and its related processes in order to achieve a given business strategy through effective re-design, information strategy planning, and alignment of technology. The re-design of the business process should also help define the IS project boundaries and scope for the

process or its sub-processes, so that the system development process can be completed in a 3 to 4 months time frame. Thus this activity should focus on process tuning through re-engineering and project scope and requirements determination.

User representatives, management representatives of the business process, a process modeling facilitator, and the IS project leader should complete the existing business process model (as-is) in detail. The process model should be developed with a given viewpoint or perspective. The purpose of developing the existing process model should also be defined and understood by the process modeling team. The modeled process should be called the 'AS-IS' process model. Once the process model is complete, a 'TO-BE' process model has to be developed by re-engineering the 'AS-IS' process. During all process modeling sessions Joint Requirements Planning techniques should be applied. Information strategies should be clearly identified during the re-engineering process. This ensures alignment of IT strategies to the business process strategies. Before starting the re-engineering sessions, visioning of strategies, goals, and objectives for the process should be done by the management and that vision must be understood clearly by the process re-engineering team. A proper methodology for business process re-engineering should be adopted and followed in a disciplined manner during the re-engineering sessions.

Depending on the scope of the business process, its requirements and its strategic role within the company, and based on how efficiently visioning and re-engineering are done, the number of process modeling sessions will vary from project to

project. Sometimes it might take a longer time to achieve a radical re-thinking of a given process and improve its strategic value.

The process modeling facilitator is responsible to make sure that the purpose of the 'AS-IS' and 'TO-BE' process models are achieved and the goals and objectives identified by the management are reached. The facilitator is also responsible for coordinating the interaction between the team members during the modeling sessions. In order to do these efficiently, the facilitator should understand group dynamics and should apply JRP techniques properly. The facilitator will document the proceedings of the sessions and also develop the process models through discussion exercises. A scribe can be appointed if necessary to document application and process specific requirements which arise out of the discussions during process modeling. Any functional requirements of the new IS application should also be documented. The project leader should start identifying informational needs of the process and also mentally visualize a possible design for an IS application which will best apply technological support and alignment to the process.

Thus at the end of this activity, the process models will be complete, the data and information needs will be identified, and the process scope will be clear. Using this process scope as a judgment criteria the project leader should judge the amount of work which can be accomplished within 3 to 4 months time frame. Sub-processes within the business process should be prioritized based on business requirements and the project scope should be identified for further prototyping and coding. Discussions should be

conducted by the management and process modeling team as to prioritizing the process components and in the identification of a manageable project scope. This helps both the business side and the IS side reach a consensus on what the project would actually deliver and when. Thus the deliverables of the project are also clearly defined at the end of this activity.

During this activity, the most enabling actions would be to conduct the modeling sessions from the view-point of the business process and its customers. Re-engineering efforts should work toward making changes that are significant to the customers of the business process. Satisfying the customer is the foremost purpose of any business process. Any organizational model therefore should take a customer-oriented approach.

During re-engineering of the process concepts such as activity based costing will help in budget analysis of the process. Benchmarking performances and performance drivers will help in establishing business metrics for the process. Benchmarking the performances also ensures quality delivered by the business process. Graphical simulation modeling of the business process may also be done in order to perform simulation analysis before actual changes are implemented in the real world. This activity is the basis for determining the best application of technology to take maximum advantage of it within the business process. Even while the business process is being re-designed envisioning of technology applications may be conducted to obtain huge benefits later.

During this activity effective tool support can provide benefits in a very long term. Contemporary tools have the capacity to provide good graphical user interfaces for user comfort. Tools may be utilized to create business process models and associate business rules and business logic with the business processes. Business processes, their data flows, controls, and mechanisms can be documented within the process model itself. They may be utilized to perform effective project planning for all the modeling activities. They also may be utilized to perform organizational analysis, activity based cost analysis, budget analysis, time and resource analysis during re-engineering the business process. Some tools also provide functions to perform benchmark analysis and what-if analysis, which are very significant and value-adding activities that need to be done during re-engineering of business processes. If all the phases are conducted with CASE or I-CASE tools, linkage to application development tools can also be achieved through them. The right choice of the tools will add extreme amount of value to the success of this activity.

Significance of a Process Model

Process models are a deviation from traditional models such as Data Flow Diagrams, Flow charts etc. While DFDs, and Flow charts can be very cumbersome, they also do not have certain advantages in their structure that a process model can offer. A process model is capable of capturing any process. The structure of a process model provides the capability to associate rules and mechanisms with the process or

activity under study. Any task or activity can be approached from a process perspective. The inputs, outputs, controls, and mechanisms help in applying a systems perspective to any task, activity, sub-process or process. A process model is a very wealthy documenting tool an organization can have. This type of documentation not only serves as a re-engineering tool during a development effort, but also as a training and educational tool, for the developer who develops the application for the business process, for new employees of the business process. The developer gains an understanding of the business process, for which he designs and codes the application. This understanding helps him to provide a better design and thorough functionality for the application. The new employee gains an understanding of the business process and therefore fits into the organization without difficulty in adapting to the procedures. Employees who work in specific business processes can understand how other business processes in the company work. Thus every employee in the organization can gain an organizational understanding of the company.

Not only can the business processes be modeled but any process can be modeled. An IS organization can model its processes. For example, it can model its development process, project management process, client support process, measurement process and so on. Developing an organizational process model can provide management the top to bottom perspective of the entire business processes. This perspective will enable the management to identify critical areas for re-engineering and improvement.

Business Application Design

The focus of this activity is completely define the requirements and functional detail of the IS application, prototype development, and determination of the system scope. Business Application Design involves the actual design of the IS application. Joint Application Design principles should be applied to involve the users in prototyping the application. The project leader/systems expert, a technology specialist, a data modeler, and a lead programmer should be involved in these sessions. Detailed functional requirements, user-specific requirements, data-model detailing, entity-relationship model detailing, security measures detailing, and prioritization of system components are completed during this activity. Iterative JAD sessions are conducted to show users the prototype and include their requirements modifications. At the end of the iterative sessions, users, business representatives, and the IS personnel reach a consensus on the functionality of the application through the development of a prototype.

Therefore, through this consensus the requirements of the IS tools can be finalized and the problem of requirements creep can be avoided. With the scope of the application, and the nature of the application clear, resource requirements for further development, and deployment may be determined. Resource requirements should include h/w, s/w installation requirements, all the users of the system, and their training needs. It should also include the necessary requirements for development efforts by the

team. Therefore at the end of the second phase, the business process model and the IS project model will be complete.

Ensuring that users correctly specify their business requirements and sharing the vision of the business process among users and developers are the most enabling actions in this activity which will assure project success and completion. It is very important that end-users are involved in the actual design of the application. They are the ones who will be working with the application. This ensures that users will be comfortable with the application and the application will help increase their personal productivity. Users should be encouraged to take ownership and pride in the application. For JAD sessions to be effective developers should be well-trained in applying group dynamics. This ensures good communication between the users and the developers. The JAD facilitator should also be well aware of the dynamics within a group of different personalities and make sure that the JAD sessions are focused on the right direction and the objectives of the sessions are reached successfully.

Project components can be prioritized based on business requirements and thus planned for incremental delivery. All requirements must be confirmed by both sides and consensus should be reached on the deliverables and expectations of the project. All the above actions ensure success of project modeling phase which essentially involves a major part of analysis and design in the development process.

During this activity, entity relationship modeling tools can be used to create ERDs. Some tools have the capacity to import the process models and identify Entity

and Relationships from them. A visual language like visual basic which has good graphical user interfaces can be used to develop the prototype of the application. Several software are available today which can provide good prototyping capabilities. CASE and I-CASE tools may be used through out the development process so that the design can also be incorporated within it. I-CASE tools have the capacity to even generate the code after this phase from the detail developed throughout the two phases. Efficient project management tools can be used to monitor the progress of the development process and also measure its speed.

Significance of Prototyping

A prototype is a working model of the new information system. A prototype performs the basic tasks that the finished system will perform but does not process true data and may not perform all the functions of the system. It is built very quickly and cheaply. Prototyping tools are so simple and easy to use that they are extremely suitable to utilize in the JAD workshops with users. During discussions with users, prototyping tools can be used to change the screen designs interactively. This effort eliminates the need for the developers to spend a lot of time in changing the design every time the user changes his /her mind. Prototyping also provides a facility for the user to visualize the functions of the information system even before it is coded.

Thus prototyping allows discussion exercises on the design of the application and also enables the user to take ownership of the design of the system. This process

enables a methodical determination of user's expectations and the management of those expectations. This process is also a 'test-drive' of the system for the users. Since there is immediate visualization of the end-product, a consensus can be reached on the scope of the functionality of the system before too much resources are spent in development of the application. This not only helps in avoiding requirements creep later in the development process but also allows the identification of unrealistic expectations.

Summary

The solution structure explained in this chapter can be utilized to create a new system development process. The first two phases of a system development process should be Project Recognition and Project Modeling. Project Recognition comprises of two activities, Organizational Information Planning and Business Process Investigation. Project Modeling comprises of two activities, Business Process Re-engineering and Business Application Design. Through these two phases one can ensure thorough systems analysis and design for the IS application.

Chapter V

SUMMARY AND CONCLUSIONS

Introduction

This chapter will summarize the solution provided by this thesis. It will also conclude the thesis through a discussion of the applicability of the solution and recommend further improvements that can be made to the system development process as a continuation of the solution for the IS organization.

Study Summary

This thesis has addressed the most significant contributors to the dis-satisfaction of IS customers, with the systems developed by IS organizations within the initial phases of the IS development process, and provided an effective and efficient solution to them. It has also provided a basic structure and shown a path for rapid development and implementation for the rest of the development process.

The development of an information system can be compared to the building of a house. When a house is built, first it should be well planned. Second, its fundamental structure should be well analyzed and modeled taking possible future additions and modifications into consideration. Third, its design should be well created to be beautiful to the eye, and make adaptation in it comfortable, pleasant, and safe. Fourth,

proper materials and tools should be chosen to construct it efficiently and as desired. Analogous to that, any IS development effort also should be well planned; its requirements well analyzed based on the business processes and strategies; its features and functionality well designed for the users' comfort, ease, and satisfaction; and its tools carefully chosen. If any of these steps are performed inadequately the end product will not have the desired quality, or effectiveness. Inefficiencies in the process will increase the time and cost to complete it and the customer, may no longer need it or need it as previously desired, or be able to afford it. Thus the very significant and value-adding efforts of planning, analyzing, and designing of information systems must be performed and performed well. Although most IS organizations know this, they don't know how to do it. The solution provided by this thesis offers a formal structure for their implementation. It identifies the focus that should be applied, the enablers that facilitate that application, the critical factors that impact upon it, the tools that should be utilized, and the objectives that must be reached upon the completion of each phase of planning, analyzing, and designing an information system.

The problems within the initial phases of the development process have been addressed and a solution has been generated. A formal development approach which is management driven, and provides for the investment of information technologies, has been defined so that an organizational perspective is applied to the development process. A new more structured way of performing planning and systems analysis has been defined. This approach provides and describes procedures for questioning

business processes so that they may be improved through re-engineering; for performing requirements analysis and specifications effectively and efficiently; and for aligning IT strategies to the business strategies. A new way of encouraging team work among management, users, and IS in planning and concurring on the scope of the project has been defined to ensure feasibility of project with respect to its scope; and agreement on requirements so that there is no requirements creep. A new way of involving users to provide them with the ownership of the project and control in the design of the system so that users (as the customers of the IS organization) are sure that their expectations will be met. This formal way of planning, analyzing and designing an information system will also ensure maximum customer satisfaction.

Maximum customer satisfaction was realized through project C, conducted by the Marketing Information Systems organization in company A when a 89% effectiveness, 100% quality, and 100% speed was achieved. A dramatic reduction of the resources consumed by the development process was realized through the case study. The customers of this project were not only extremely satisfied with the IS product but also were so immensely impressed with the methodology that they are taking immediate efforts to convince their Manufacturing Information Systems organization to adopt the new methodology. Other IS organizations supporting various other business groups within the company have seen the results and therefore are making immediate plans to adapt it to their organization. This enthusiasm displayed by all the groups proves that the solution developed by this thesis has proven to provide the best results.

Conclusions

The solution provided is universally applicable in any environment. Company A is implementing it in the mainframe and has implemented in the client/server environments. Most of the principles applied are independent of the system architecture. They take into account the basic structure of any organization which is conducting business with its customers. All aspects of a development process have been considered and included in the solution. Any organization can utilize this information and guidance to structure its system development process.

But, for any organization to adopt this solution and achieve success, management's (from all levels) understanding of concepts and ideas incorporated within the solution, their interest and support in re-engineering their development process, their realization of the significance of organizational commitment to the new development approach are very important.

The results of project C, (the case study) may have been very impressive. But, the effectiveness achieved through the project was only 89%. This was because of one simple reason. That is, the lack of a thorough understanding of the underlying concepts and principles of the methodology among managers, users, and the IS personnel. There is a lack of understanding of what process re-engineering and process improvement is all about. Most of the participants in project C do not have a formal education or training in process re-engineering. Therefore, there was no dramatic or radical re-thinking of the business process when project C was performed. The business process

had so much potential for re-engineering. This lack of knowledge of business process redesigns has impacted the effectiveness of the project.

Thus, the solution provided by this thesis may be a very efficient and effective development process, but for it to work, educational and training needs for the participating personnel should be identified and provided. For any method to work, expertise is essential to achieve maximum effectiveness.

Recommendations

This thesis has re-engineered only the initial phases, those phases that are most significant to the results of the development process. It has provided the basic structure for rapid development. The actual case study, project C was an intentionally low-sized project. However, the validitiy of the methodology on a larger project has to be tested based on the size of the organization. The questions of whether a large project can be divided into several sub-projects and simultaneously developed by several teams of limited sizes has to be investigated; At which phase the project has to be sub-divided i.e. before or after BPR; Should the design be done together or can it be done as separate teams; Should coding be done as single team or separate teams; have to be answered.

Also, the questions of (1) how rigidly all the objectives of this strategic development process has to be followed; (2) what are the factors and elements which might influence a deviation from it; and (3) On what basis those deviations may be

justified; have to be further investigated. Re-engineering is a dramatical re-thinking of the business process. How often it is done depends on the organizational strategies. For example, questions such as, how often do the business processes have to be prioritized ? Does the underlying business process have to be completely investigated and have to be re-engineered every time an development effort is performed for application enhancements ? have to answered. A structured and thorough decision making process has to be designed for this effort to provide guidance to organizations.

The actual development(coding) of the information system, its implementation, and other support processes need to be addressed in order to completely re-engineer the development process. As previously stated, when an IS organization has the best development process, its need for several support processes such as problem management, maintenance, help-desk support or client support will be greatly reduced. This elimination of the need of such processes is a benefit to the IS organization in the form of savings in resources.

Even if the development process is completely re-engineered to be effective and efficient, the purpose of a proper metrics, client support, quality assurance, project management or other processes should be investigated and those processes be re-engineered to adapt to the new development process. For IS organizations to be highly productive they have to adopt formally structured processes and follow them with a discipline.

Summary

The solution provided by this thesis has proven to be an improvement over the traditional development process. IS organizations may utilize the solution to improve their development process. They need to further investigate all their processes and re-engineer them to realize dramatic organizational improvements. They also need to identify processes that are absent in the current environment but have the potential to add immense value to their productivity.

REFERENCES

REFERENCES

F. J. Aiosa, "The Marriage of Sales and Technology", Best's Review (May 1989).

S. Alter, "Information System - a management perspective", Second Edition, Benjamin/Cummings publishing company, inc.

D. C. Andrews, "JAD: A Crucial Dimension For Rapid Applications Development", Journal of Systems Management (March 1991) pp. 23-31.

G. H. Anthes, " Welcome TO The UNKNOWN ZONE", Computerworld (February 1993) pp. 55-56.

G. H. Anthes, "No More Creeps", Computerworld (May 1994) pp. 107-110.

D. Asbrand, "User satisfaction is essential to successful projects", Inforworld (February 1993) pp. 50.

D. Baum, "Go Totally RAD and Build Apps Faster", Datamation (September 1992), pp. 79-81.

D. Baum, "Leave analysis behind", Computerworld (June 1994), pp. 112.

D. Baum, "The Right Tools For Coding Business Rules" Datamation (March 1995) pp. 36-38.

J. Bradley, "An Educational Experience at Aetna", Datamation (April 1989), pp. 46-47.

A. Bredin, "Benchmarking IS IT Right For Your Operation" Computerworld

E. Child, "High Speed Teams Get Lend Lease Trucks Rolling", Journal of Systems Management (January 1994) pp. 18-21.

C. C. Cole, M. L. Clark, C. Nemee, "Reengineering Information Systems at Cincinnati Milacron"(Case Study), Planning Review (May/Jun 1993), pp. 22-48.

D. S. Corbin, "Team Requirements Definition: Looking for a mouse and finding an elephant" (May 1991) pp. 28-30.

T. H. Davenport, J. E. Short, "The New Industrial Engineering: Information Technology and Business Process Redesign", Sloan Management Review (Summer 1990), pp. 11-27.

T. H. Davenport, "Need Radical Innovation and Continuous Improvement? Integrate Process Re-engineering and TQM", Planning Review (May/Jun 1993), pp. 6-12.

A. Davidson, "Strategic Management Software and System Trends", Planning Review (Jul-Aug 1993), pp. 35-37.

D. B. Davis, "Does Your Is Shop Measure Up ?", Datamation (September 1992) pp. 27-32.

J. Dempsey, W. Koff, " Increasing IS Productivity: A Holistic Approach", Information Strategy: The Executive's Journal (Summer 1995) pp. 5-12.

C. A. Dykman, R. Robbins, "Organizational Success Through Effective Systems Analysis", Journal Of Systems Management (July 1991) pp. 6-8.

W. B. Foss, "Fast, Faster, Fastest Development", Computerworld (May 1993), pp.82-83.

P. Fogelsanger, "Selecting The Right Tools For Client/Server: A NASA Perspective", Journal of Systems Management (April 1992) pp.23-27.

T. R. Furey, "A Six-step Guide To Process Reengineering", Planning Review (Mar-April 1993), pp. 20-23.

T. R. Furey, J. L. Garlitz, and M. L. Kelleher, "Applying Information Technology to Reengineering", Planning Review (November/December 1993), pp. 22-25

A. Gill, "Accelerated Design Techniques: Methods Without Madness", Best's Review

V. Grover, K. D. Fiedler, and J. T. C. Teng, "Exploring the Success of Information Technology Enabled Business Process Reengineering", IEEE Transactions on Engineering Management Vol.41 (August 1994), pp.276-284.

J. Gallapsy, "Why JAD goes bad ?", Computerworld (April 1994), pp. 87-88.

R. Garner, "Family Feud", Computerworld (November 1994) pp. 85-90.

M. Gentle, "Technology is no solution", Computerworld (June 1994), pp. 113.
R. B. Grady, "Practical software metrics for project management and process improvement") Prentice Hall, Inc Book (1992).

L. Goff, "Benchmarking resources grow for IS managers", Computerworld (November 1993) pp. 136-137.

M. Hammer, "Reengineering Work: Dont Automate, Obliterate", Harvard Business Review (July/August 1990), pp. 104-112.

M. Hammer, Glenn E. Mangurian, " The changing value of communications technology," Sloan Management Review.

C. L. Harris, "Information Power", Business Week (October 14, 1985), pp. 108-114.

J. T. C. Heng, V. Grover, K. D. Fiedler, "Business Process Reengineering: Charting a Strategic Path for the Information Age," California Management Review (Spring 1994), pp.9-31.

T. Hoffman, "IBM study spurs IS reevaluation", Computerworld

J. D. Hofman, J. F. Rockart, "Application Templates: Faster, Better, and Cheaper Systems" Sloan Management Review (Fall 1994) pp. 49-58.

T. J. Housel, C. J. Morris, C. Westland, "Business Process Reengineering at Pacific Bell"(Case Study), Planning Review (May-Jun 1993), pp. 28-33.

P. M. Howman, "Freeing Underwriters for the Tough Jobs", Best's Review (November 1988) pp. 54-56.

S. L. Huff, "Reengineering the Business", Business Quarterly (Winter 1992), pp. 38-41.

M. A. Janson, C. C. Woo, "Comparing IS development tools and methods: Using speech act theory", Information & Management (28, 1995) pp. 1-12.

K. G. Jin, "Overcoming Organizational Barriers to Systems Development: An Action Strategy Framework", Journal Of Systems Management (May 1993), pp. 28-33.

P. A. Kendall, "Introduction To Systems Analysis and Design", Book (1989)

J. King, "Personnel Paybacks", Computerworld (Aug 1994)

A. Laplante, "Project management puts jewelry maker on track", Infoworld (July 1993)

M. Ligeti, "Corporate reengineering should not stop at the factory door", Industrial Engineering (August 1994), pp. 14-16.

Lee The, "Now You Can Automate BPR", Datamation (March 1995) pp. 61-65.

M. J. Mandel, C. Farrell, " The Technology Payoff", Business Week (June 1993), pp.56-73.

F. W. McFarlan, "Information Technology changes the way you compete", Harvard Business Review (May-June 1984),pp 98-103.

J. Moad, " Outsourcing the Help Desk: First Aid or Folly ?", Datamation (December 1994) pp. 44-46.

J. Moad, "Successful Benchmarking With The Team Approach", Datamation (February 1994) pp. 53-56.

M. E. Porter, V. E. Miller, "How information gives you competitive advantage," Harvard Business Review (July-August 1985) pp. 149-160.

P. Prairie, "An American Express/IBM Consortium Benchmarks Information Technology", Planning Review (Jan-Feb 1993), pp. 22-27.

V. V. Raghavan, J. Webster, "Strategic Traps In Systems Development", Journal Of Systems Management (December 1992), pp. 8-11.

H. A. Rubin, "IT Baselining and Benchmarking", Information Strategy: The Executive's Journal (Summer 1995) pp. 13-25.

J. B. Rochester, D. P. Douglass, "Improving Application Development Productivity", I/S Analyzer (March 1990), pp. 1-16.

J. Rozum, "A Way to Improve Customer Satisfaction", Quatlity Progress (October 1994) pp. 67-71.

D. E. Y. Sarna, G. J. Febish, "The Case Against CASE", Datamation (July 1994) pp. 19-20.

D. L. Schnitt, "Reengineering the organization using information technology", Journal of Systems Management (January 1993), pp. 14-20.

D. J. Schoch, P. A. Laplante, "A real-time systems context for the framework for information systems architecture", IBM Systems Journal (Vol 34, No. 1 1995) pp. 20-38.

B. Smith, " FedEx's Key to Success", Management Review (July 1993) pp. 23-24.

N. R. Stewart, " Tooling Up," Management Accounting (October 1994), pp. 55-58.

R. P. Stow, "Reengineering by Objectives", Planning Review (May-Jun 1993), pp. 14-16.

D. B. Tesch, G. Klein, M. G. Sobol, "Information Systems Professional' Attitudes: Development Tools and Concepts", Journal of Systems Management (28, 1995) pp. 39

N. Venkatraman, "IT-Enabled Business Transformation: From Automation to Business Scope Redefinition", Sloan Management Review (Winter 1994), pp. 73-87.

P. Wallace, "Don't Pull Your Hair Out", Infoworld (August 1994) pp. 53-54.

T. Yager, "How I Learned To Live With Benchmarks", Open Computing (September 1994) pp. 56-62.

APPENDICES

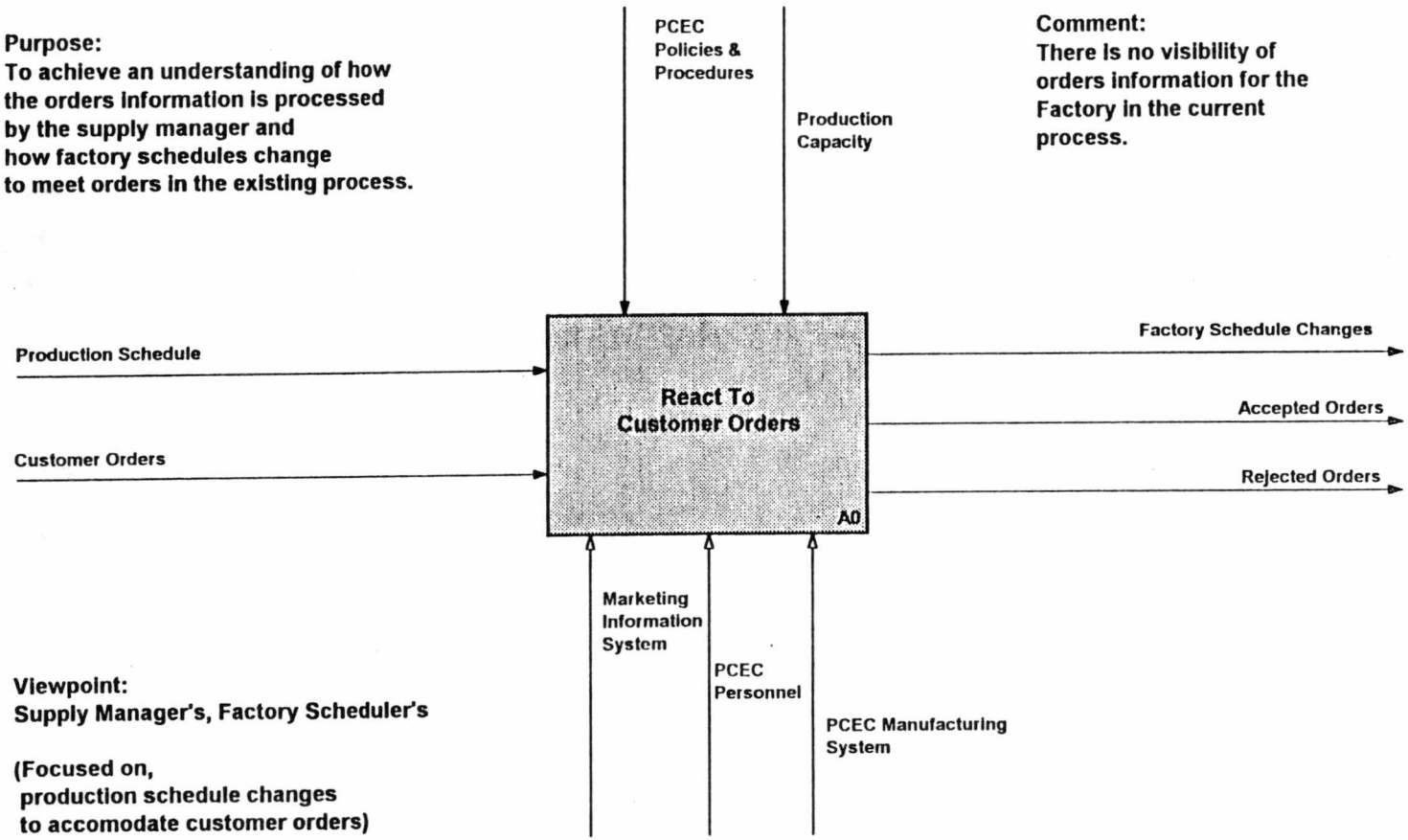
APPENDIX A

BUSINESS PROCESS MODELS

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 27 Sep. 1995		WORKING	READER DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'AS-IS'	REV: 31 Oct. 1995		DRAFT		TOP
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED		
			■	PUBLICATION		

Purpose:
To achieve an understanding of how the orders information is processed by the supply manager and how factory schedules change to meet orders in the existing process.

Comment:
There is no visibility of orders information for the Factory in the current process.

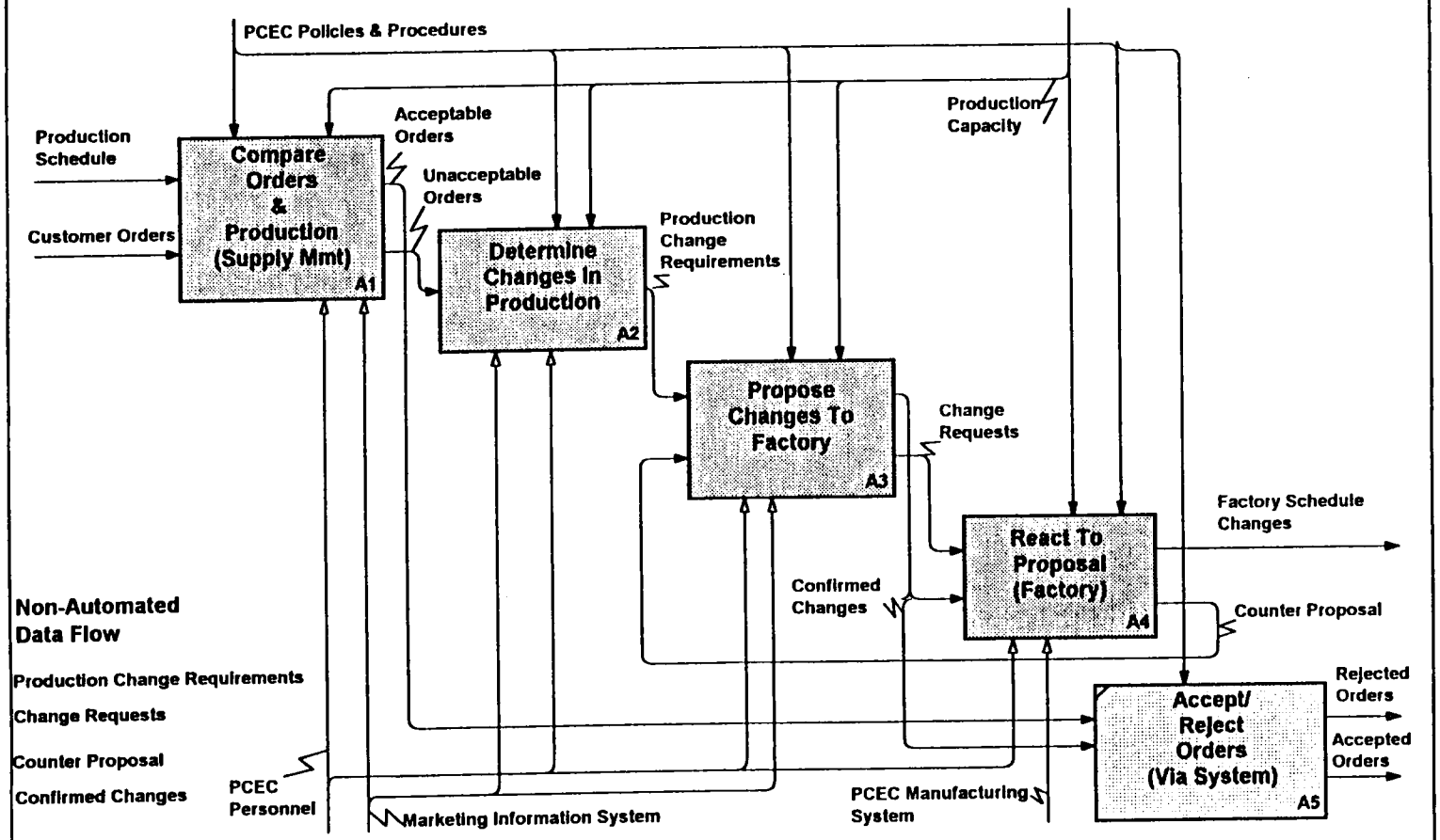


Viewpoint:
Supply Manager's, Factory Scheduler's

(Focused on, production schedule changes to accomodate customer orders)

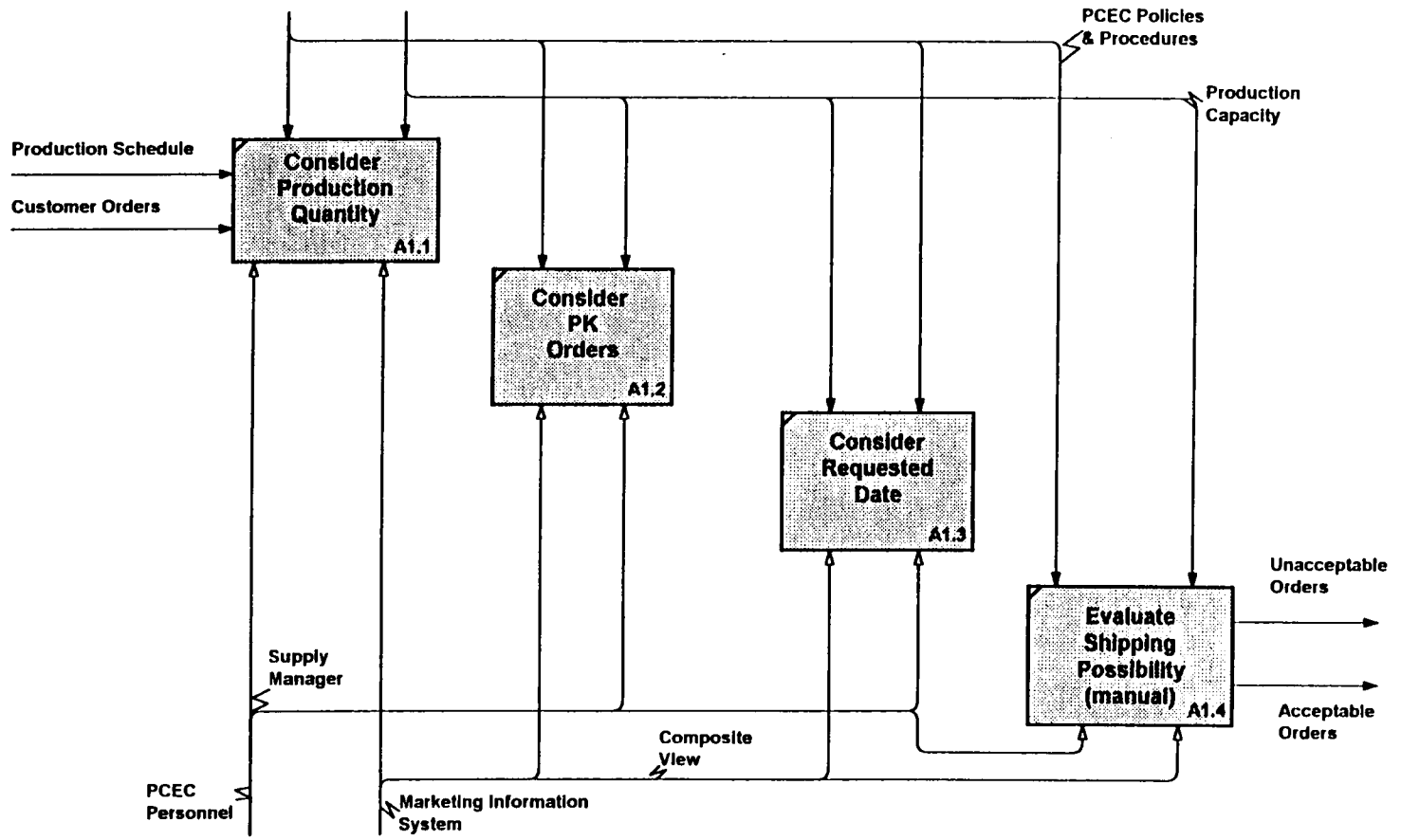
NODE: A-0	TITLE: React To Customer Orders	NUMBER:

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 27 Sep. 1995		WORKING	READER DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'AS-IS'	REV: 31 Oct. 1995		DRAFT		TOP
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED		
			■	PUBLICATION		A-0



NODE: A0	TITLE: React To Customer Orders	NUMBER:
		2

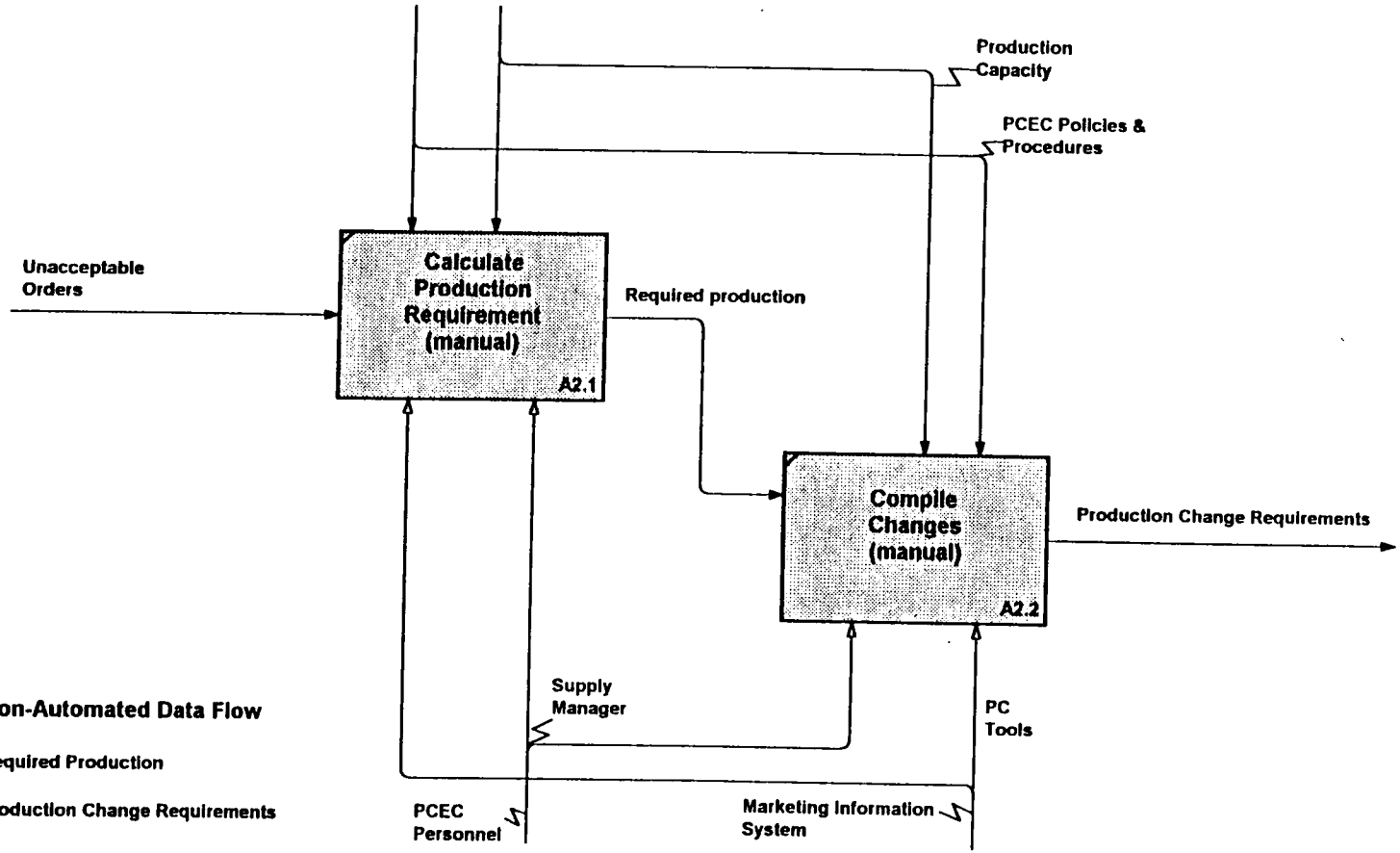
USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 29 Sep. 1995		WORKING	READER DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'AS-IS'	REV: 31 Oct. 1995		DRAFT		
				RECOMMENDED		
	NOTES: 1 2 3 4 5 6 7 8 9 10		■	PUBLICATION		A0



NODE: A1	TITLE: Compare Orders & Production (Supply Mmt)	NUMBER:

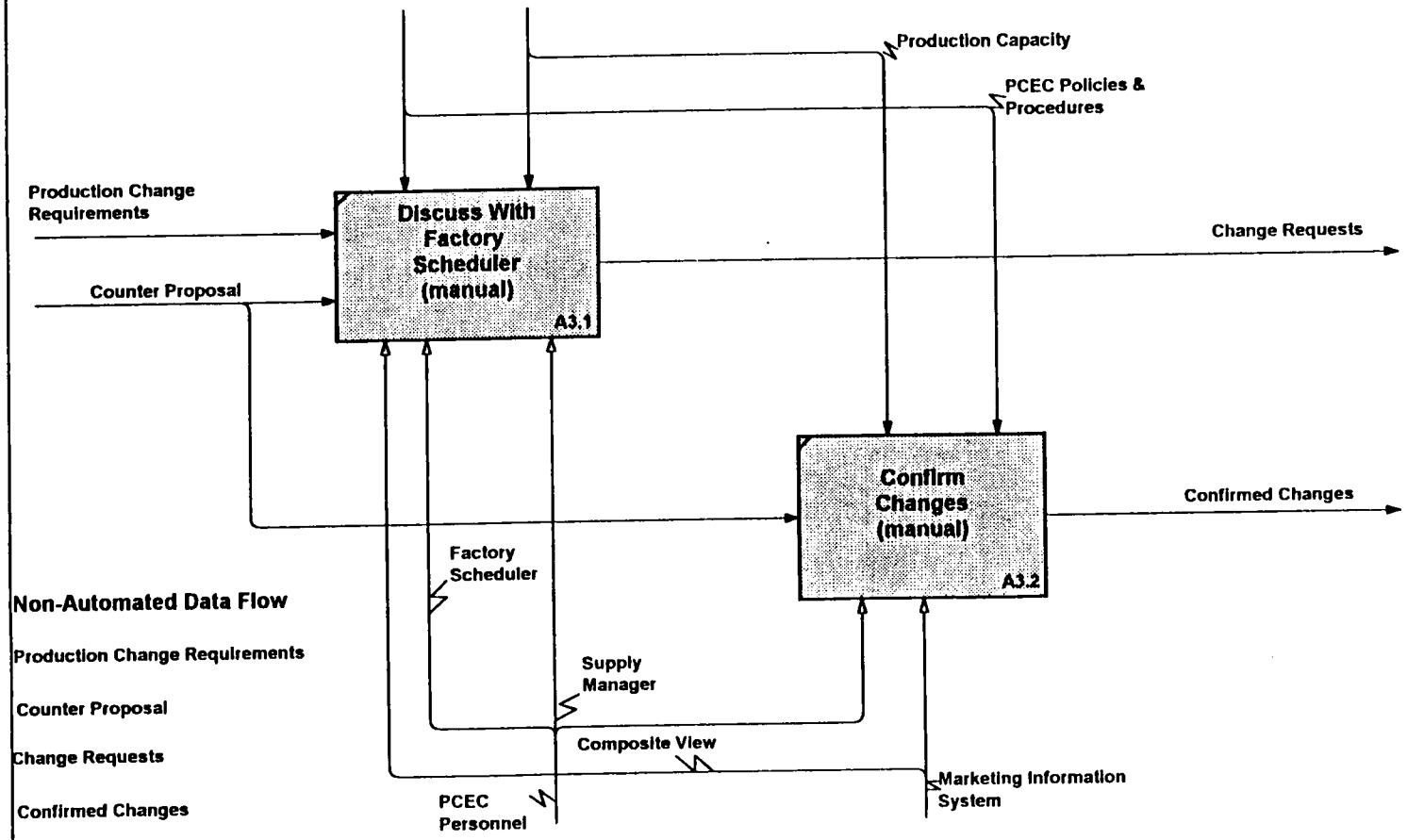
USED AT: PCEC Mgmt & Factory	AUTHOR: Sowmya Thiagarajan PROJECT: Orders To Factory 'AS-IS'	DATE: 29 Sep. 1995 REV: 31 Oct. 1995	WORKING DRAFT RECOMMENDED PUBLICATION	READER DATE	CONTEXT: A0

NOTES: 1 2 3 4 5 6 7 8 9 10



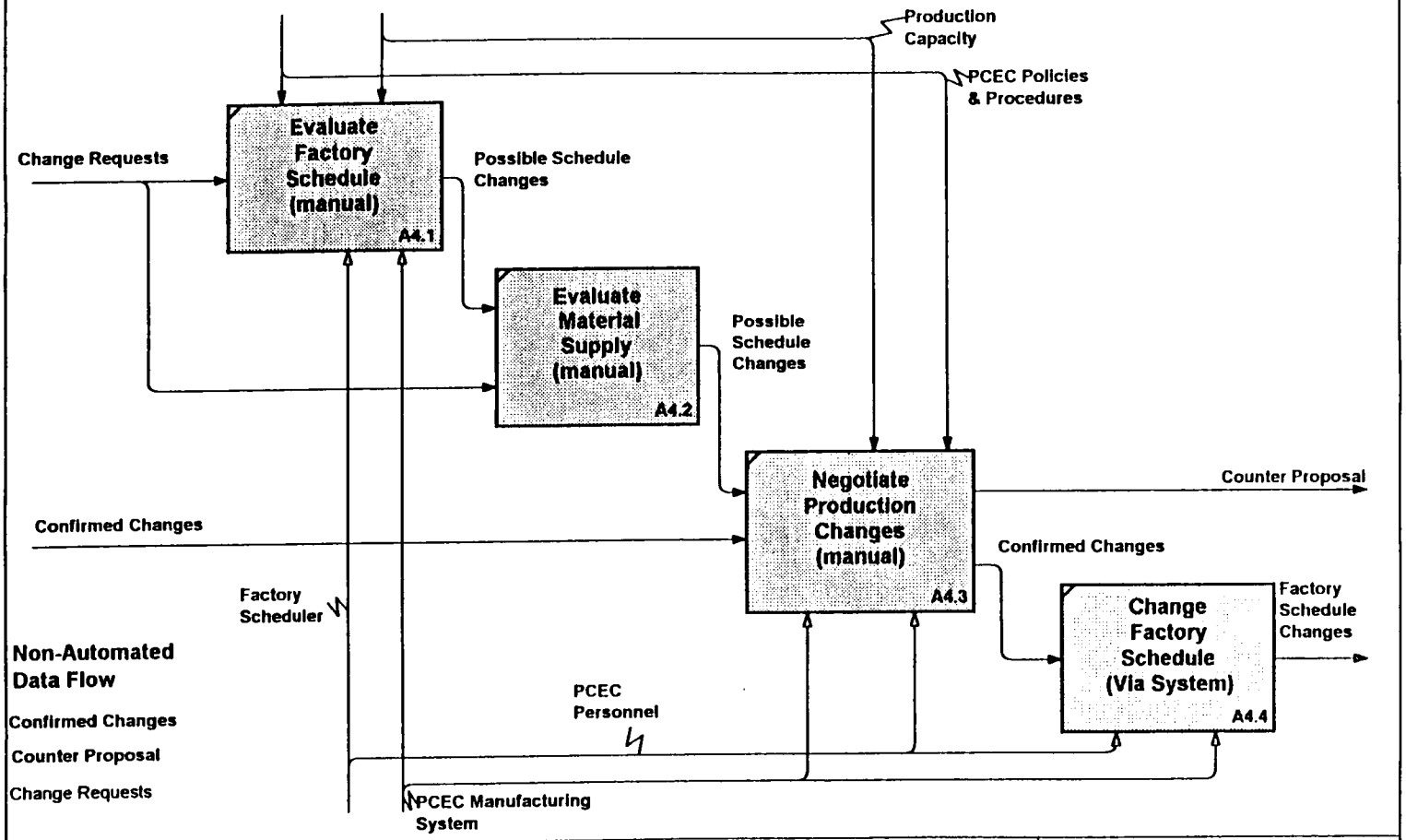
NODE: A2	TITLE: Determine Changes In Production	NUMBER:

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 29 Sep. 1995		WORKING	READER DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'AS-IS'	REV: 31 Oct. 1995		DRAFT		
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED		
			■	PUBLICATION		A0



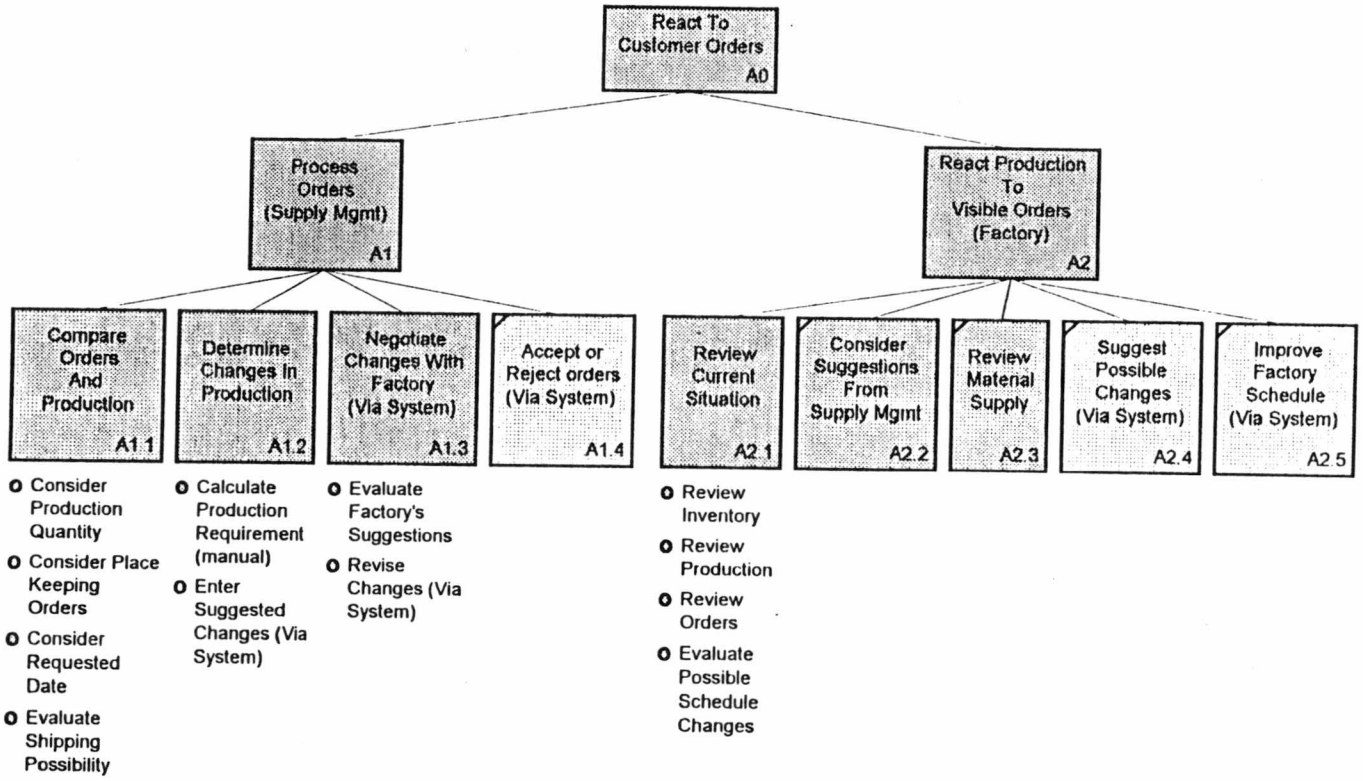
NODE: A3	TITLE: Propose Changes To Factory	NUMBER: 5

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 29 Sep. 1995	WORKING	READER	DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'AS-IS'	REV: 31 Oct. 1995	DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10		RECOMMENDED			
			PUBLICATION			A0



NODE: A4	TITLE: React To Proposal (Factory)	NUMBER:

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 19 Oct. 1995	WORKING	READER DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'TO-BE'	REV: 31 Oct. 1995	DRAFT		TOP
	NOTES: 1 2 3 4 5 6 7 8 9 10		RECOMMENDED		A-0
			PUBLICATION		

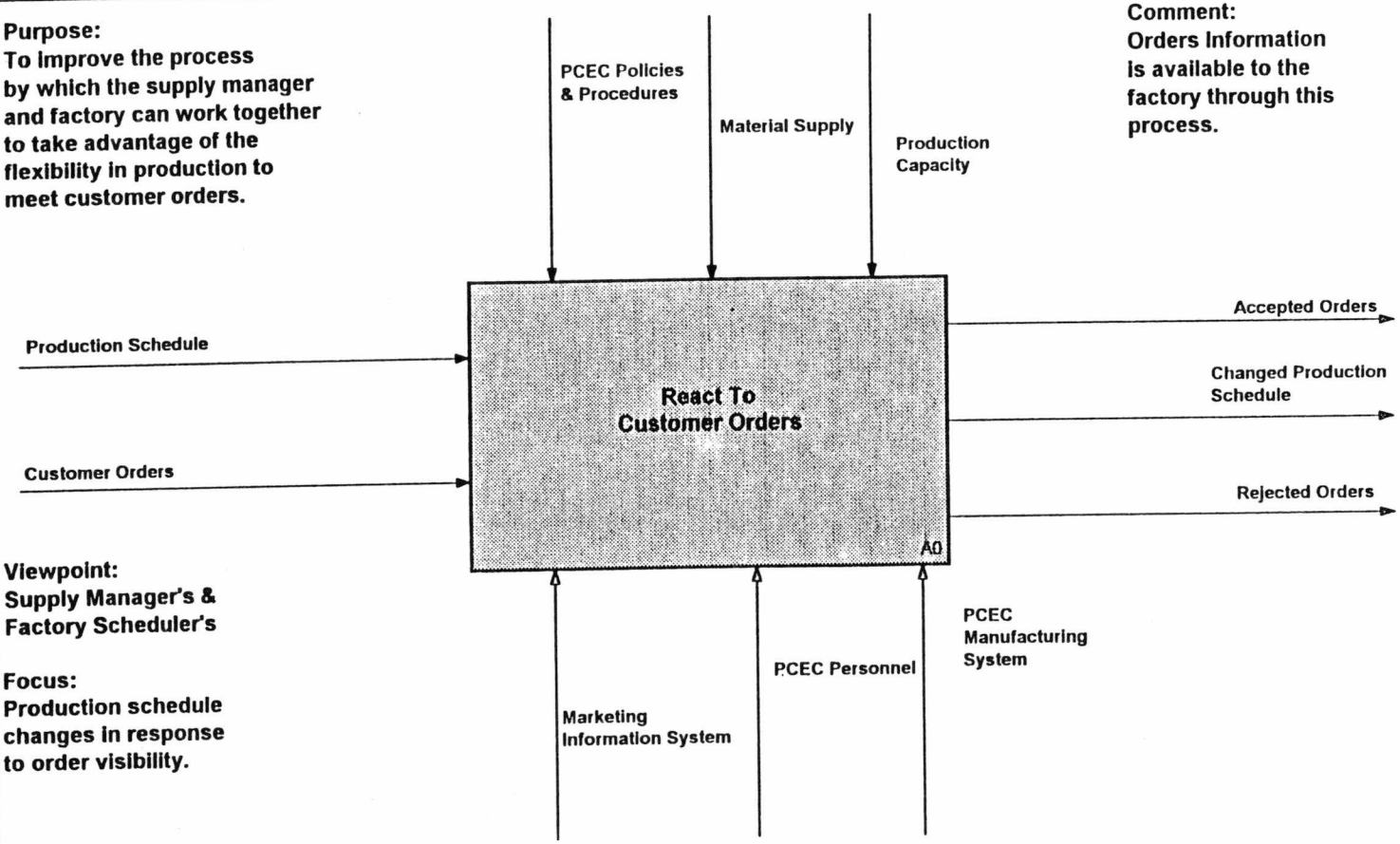


NODE: A0	TITLE: Process Structure	NUMBER:

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 4 Oct. 1995	WORKING	READER DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'TO-BE'	REV: 31 Oct. 1995	DRAFT		TOP
	NOTES: 1 2 3 4 5 6 7 8 9 10		RECOMMENDED		
			PUBLICATION		

Purpose:
To improve the process by which the supply manager and factory can work together to take advantage of the flexibility in production to meet customer orders.

Comment:
Orders Information is available to the factory through this process.

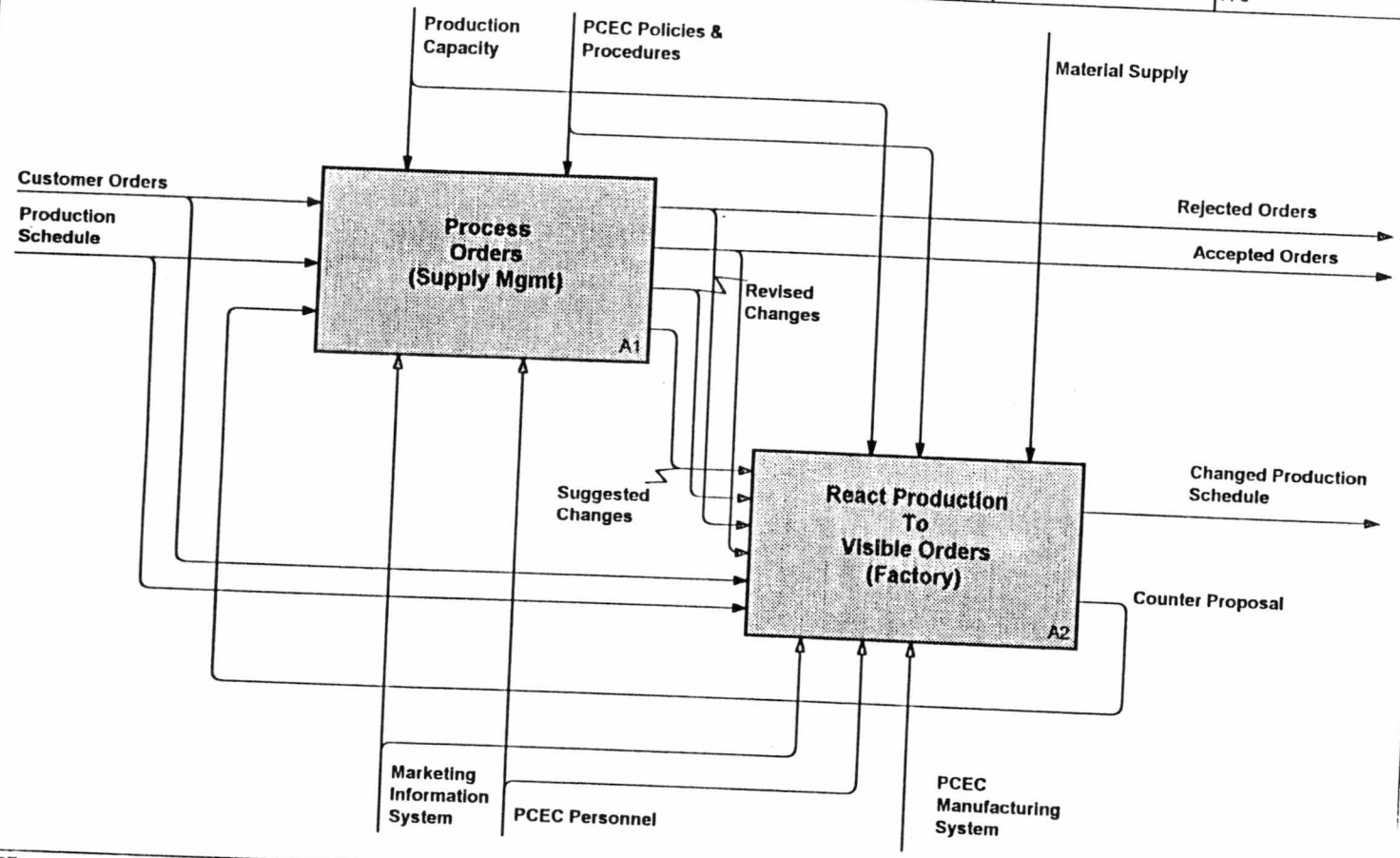


Viewpoint:
Supply Manager's & Factory Scheduler's

Focus:
Production schedule changes in response to order visibility.

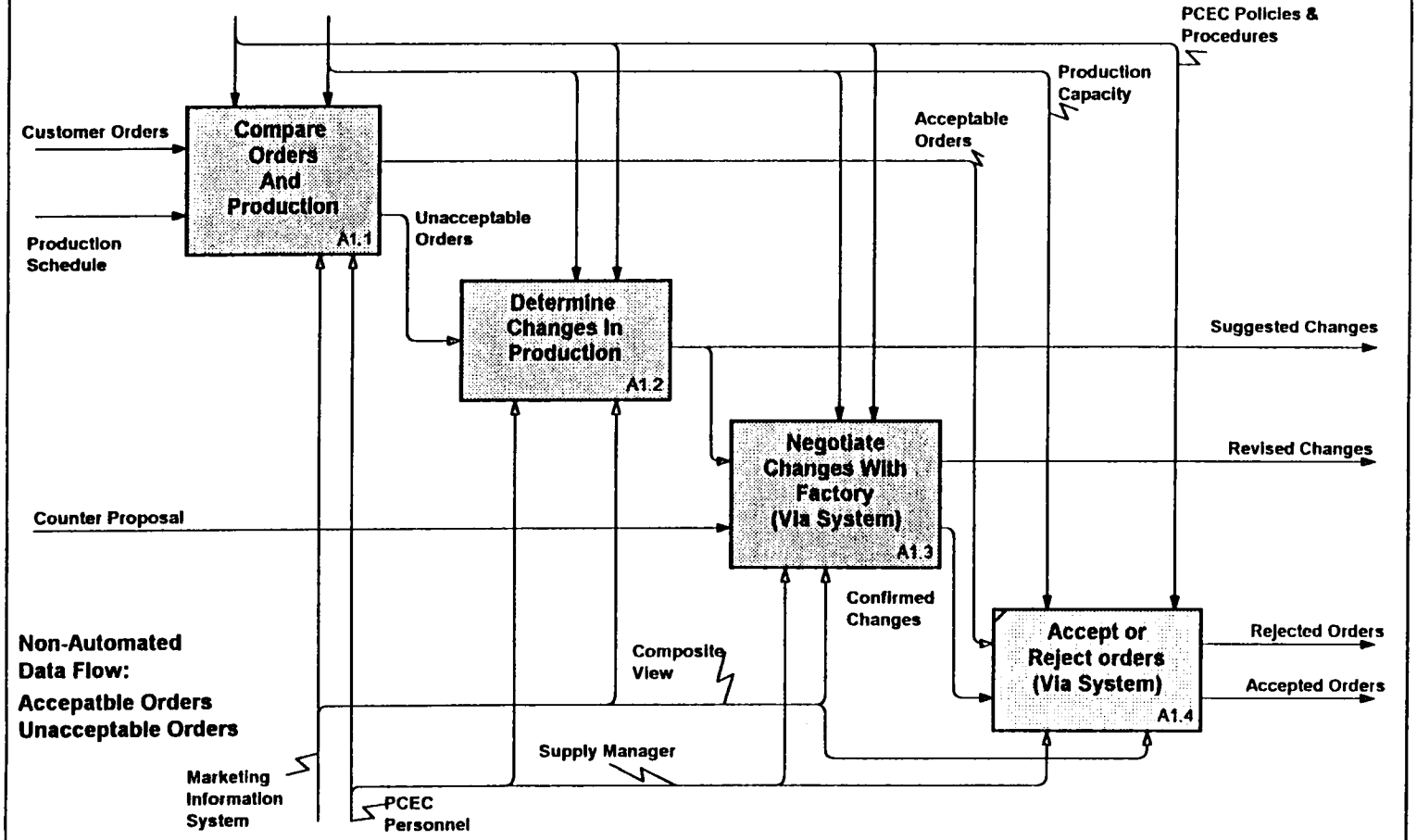
NODE: A-0	TITLE: React To Customer Orders	NUMBER: 1

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 4 Oct 1995	WORKING	READER DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'TO-BE'	REV: 31 Oct. 1995	DRAFT		TOP
	NOTES: 1 2 3 4 5 6 7 8 9 10		RECOMMENDED		A-0
			PUBLICATION		



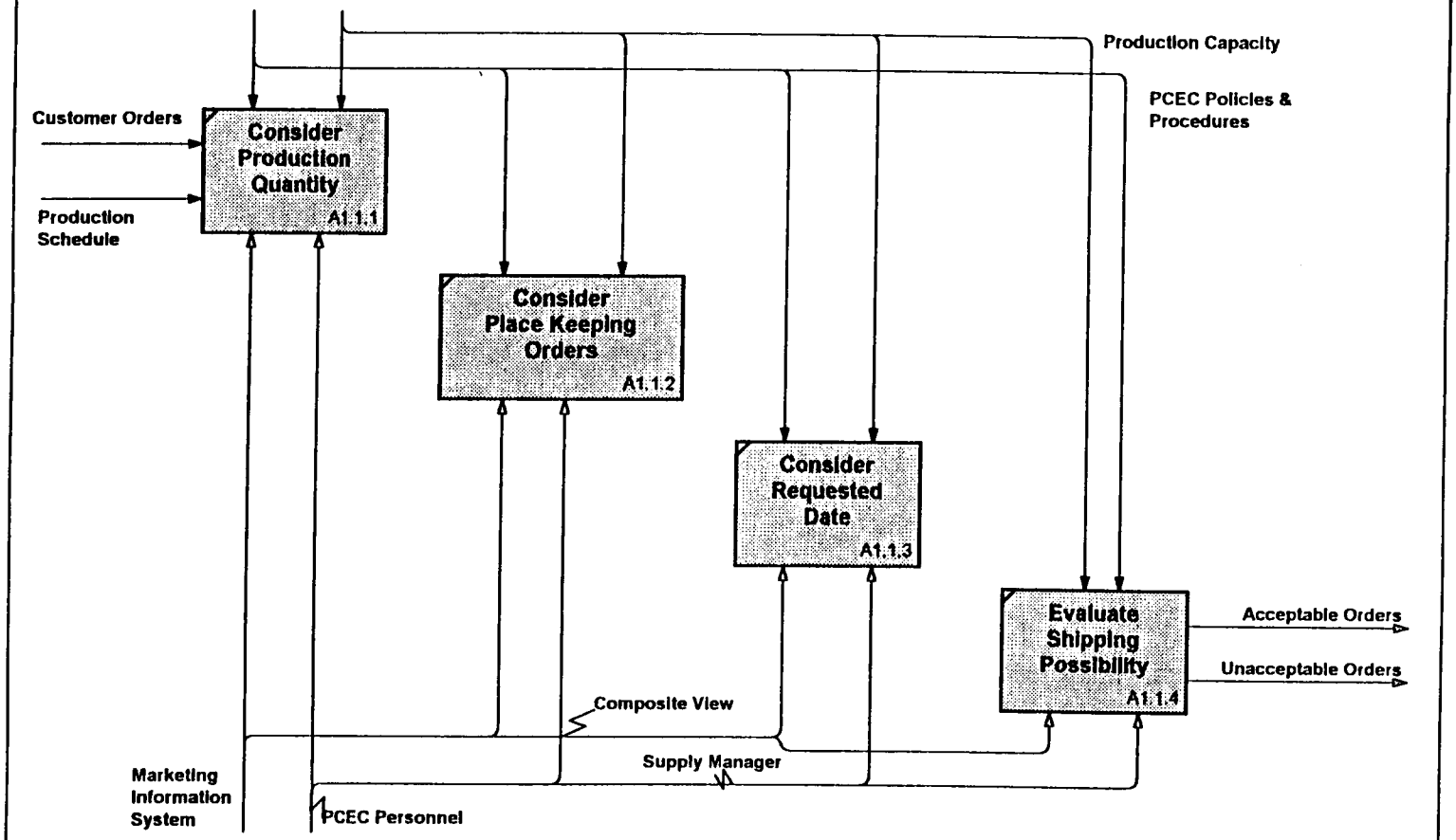
NODE: A0	TITLE: React To Customer Orders	NUMBER:
		2

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 4 Oct. 1995	WORKING	READER DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'TO-BE'	REV: 31 Oct. 1995	DRAFT		
	NOTES: 1 2 3 4 5 6 7 8 9 10		RECOMMENDED		
			PUBLICATION		A0



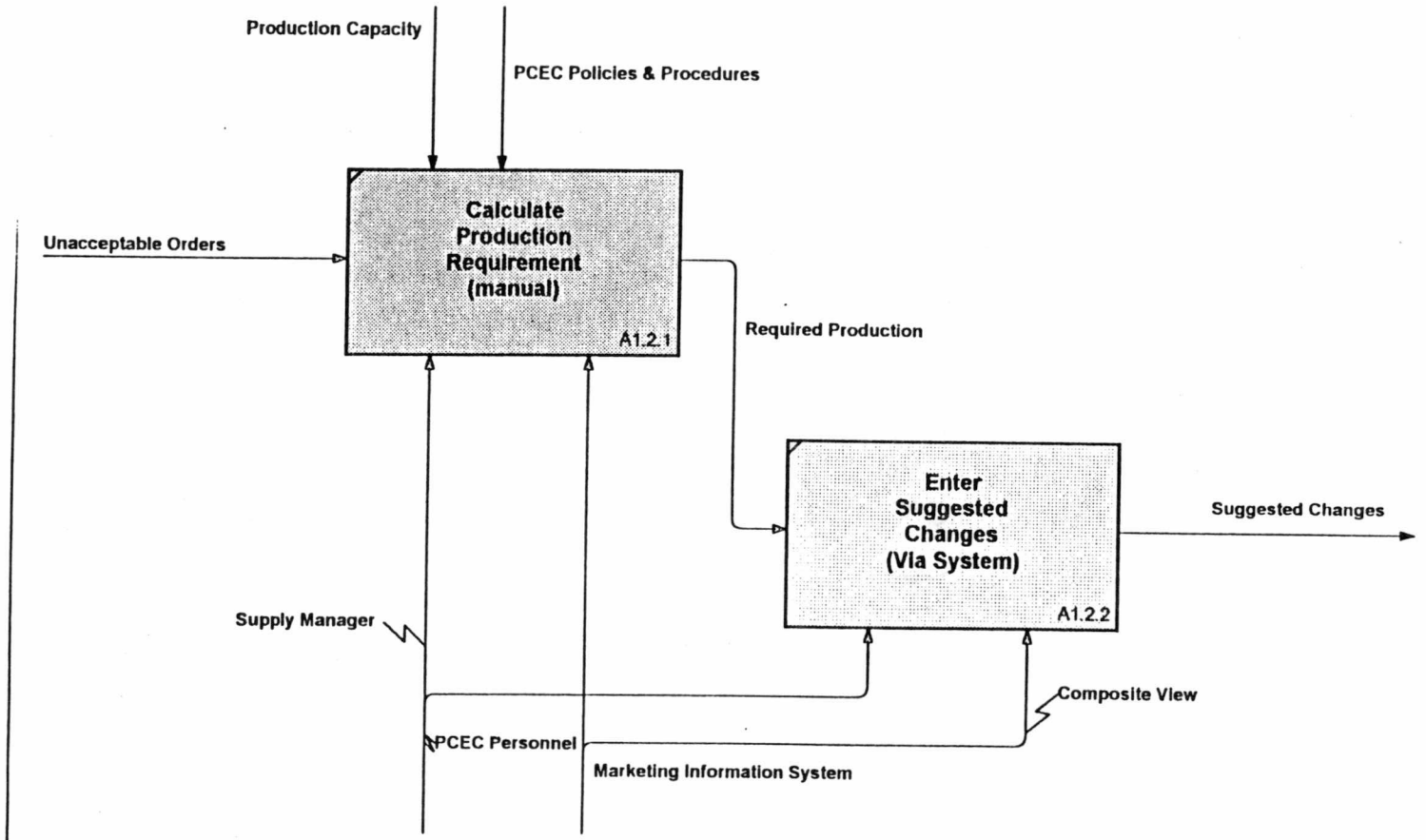
NODE: A1	TITLE: Process Orders (Supply Mgmt)	NUMBER:

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 19 Oct. 1995	■ WORKING	READER DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'TO-BE'	REV: 31 Oct. 1995	DRAFT		
	NOTES: 1 2 3 4 5 6 7 8 9 10		RECOMMENDED		
			PUBLICATION		A1



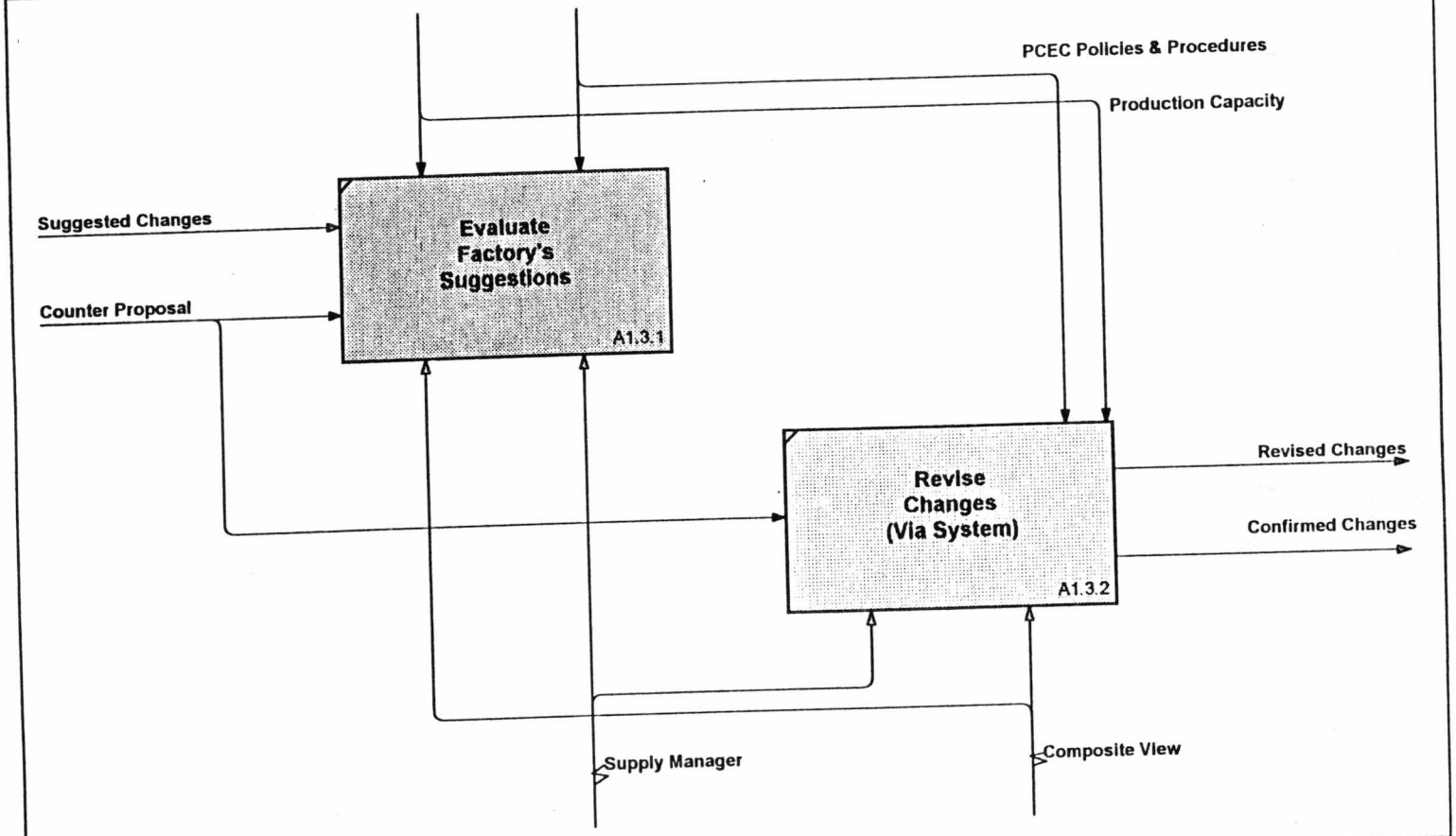
NODE: A1.1	TITLE: Compare Orders And Production	NUMBER:

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 19 Oct. 1995	WORKING	READER	DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'TO-BE'	REV: 31 Oct. 1995	DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10		RECOMMENDED			
			PUBLICATION			A1



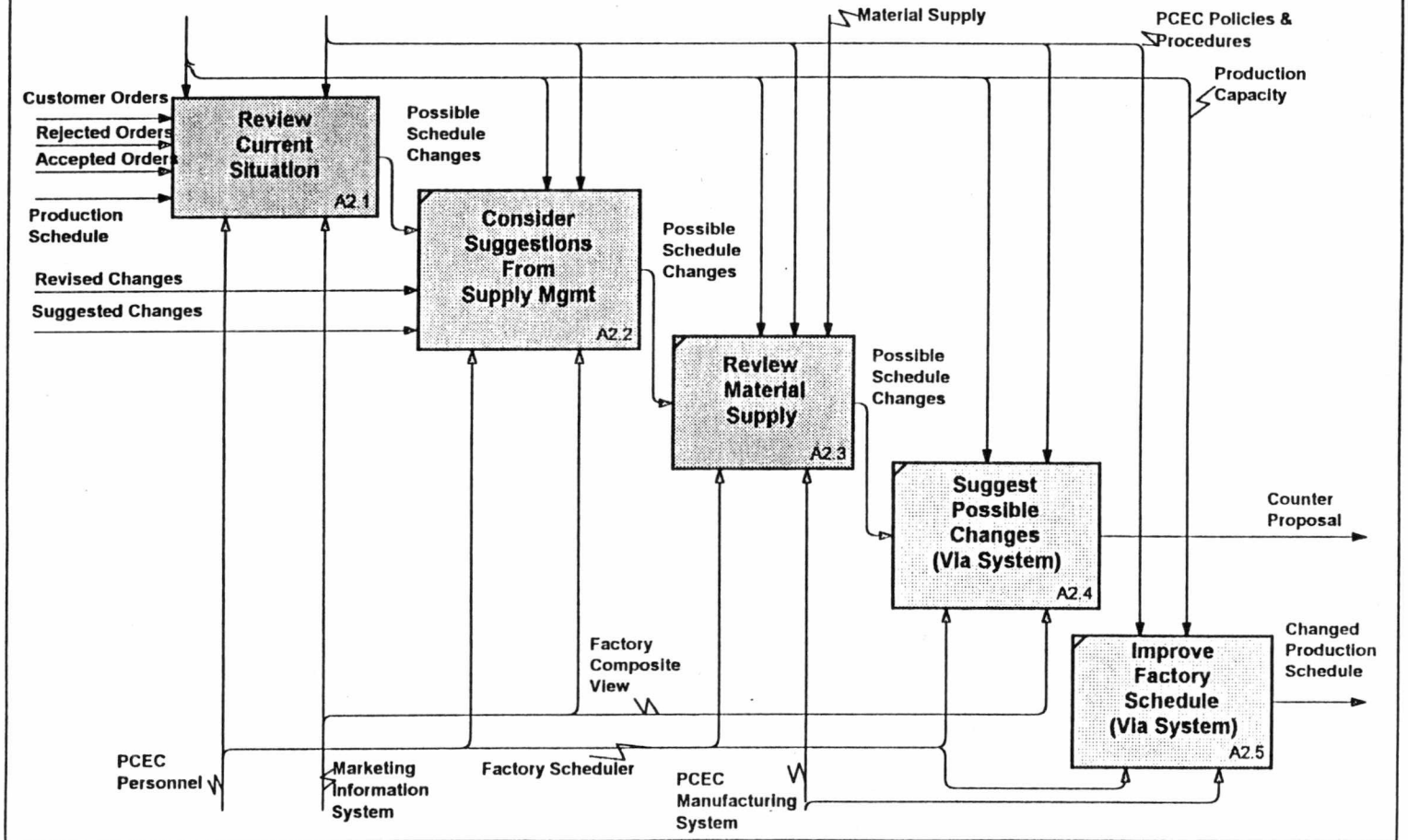
NODE: A1.2	TITLE: Determine Changes In Production	NUMBER:

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 19 Oct. 1995	■ WORKING	READER DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'TO-BE'	REV: 31 Oct. 1995	DRAFT		A1
	NOTES: 1 2 3 4 5 6 7 8 9 10		RECOMMENDED		
			PUBLICATION		



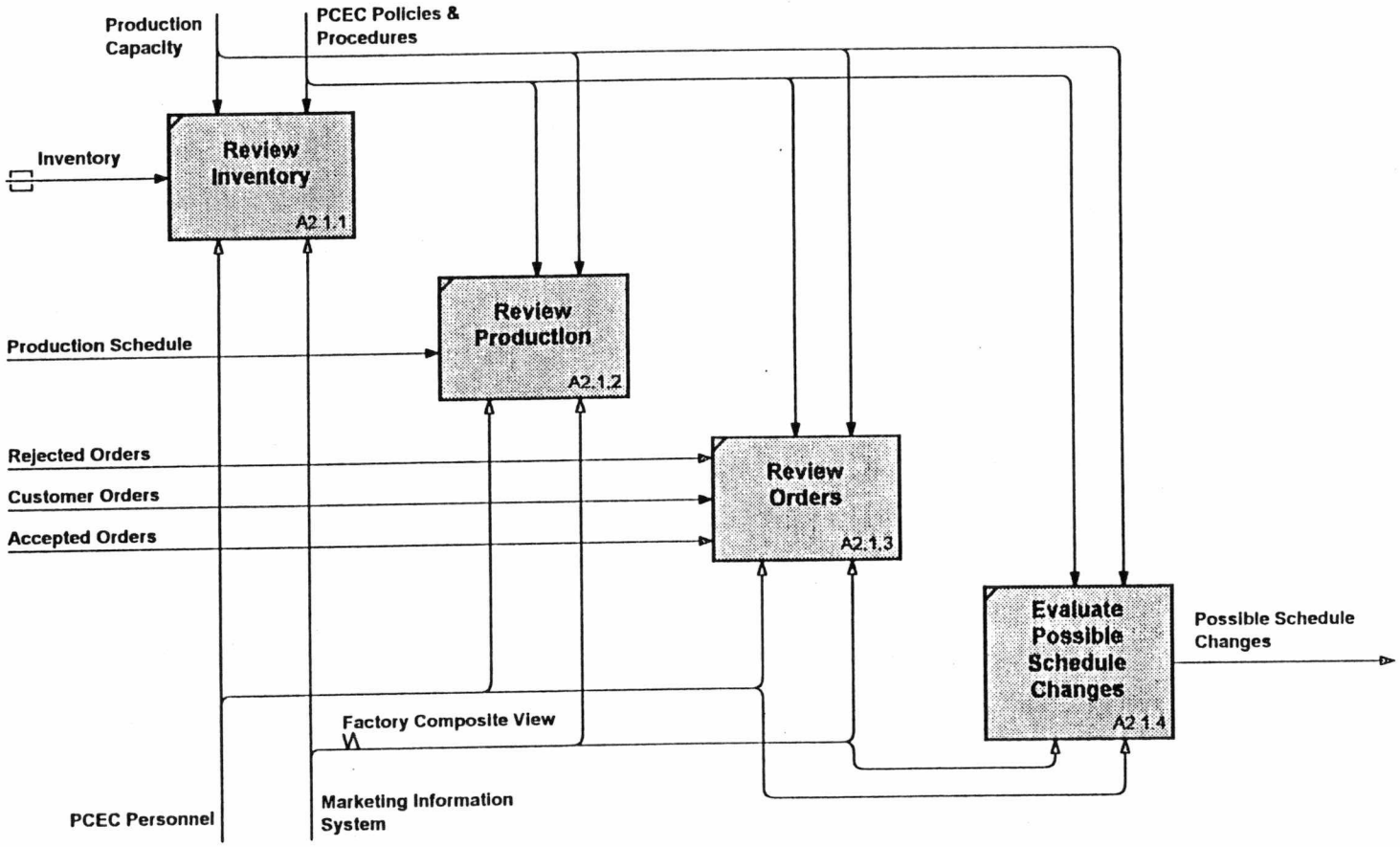
NODE: A1.3	TITLE: Negotiate Changes With Factory (Via System)	NUMBER:

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 4 Oct. 1995	■ WORKING	READER DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'TO-BE'	REV: 31 Oct. 1995	DRAFT		
			RECOMMENDED		
	NOTES: 1 2 3 4 5 6 7 8 9 10		PUBLICATION		A0



NODE: A2	TITLE: React Production To Visible Orders (Factory)	NUMBER:

USED AT:	AUTHOR: Sowmya Thiagarajan	DATE: 30 Oct. 1995	WORKING	READER	DATE	CONTEXT:
Supply Mgmt & Factory	PROJECT: Orders To Factory 'TO-BE'	REV: 30 Oct. 1995	DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10		RECOMMENDED			
			PUBLICATION			A2



NODE: A2.1	TITLE: Review Current Situation	NUMBER:
		8

APPENDIX B

TERMINOLOGY

TERMINOLOGY

Business Process
A process which exists within a company and serves the customer directly or indirectly.

BPR
Business Process Redesign

Business Rules
Those rules determined by the managment as to how a business process should function. Business processes are regulated by the associated rules.

Critical Factors
Significant issues or practices which have a high influence on the quality and effectiveness of results achieved by an activity or a sub-process within a system development process.

Effectiveness
Focus on optimizing use of resources, implementing a structured environment. One of the aspects of IS productivity identified by J. Dempsey et al.

Efficiency
The relative measure of the total quality and effectiveness of a process with respect to the resources applied to it. Resources can be time, money, manual skills.

Enabler
Action based on IS techniques, principles, rules, and concepts which facilitate and steer the activity in the right direction, add a significant amount of value to that activity. These influence the effectiveness and quality of the outcome of an activity or a sub-process within the system development process.

Environment
The existing nature of the architecture of the systems, type of management, type of industry, or human culture in an organization.

Focus
Regulation or Control applied to an activity or sub-process within the system development process in order to achieve certain objectives.

IT
Information Technology

IT alignment
The application of information technology to a process in such a way that the technology performs appropriately chosen parts of the process efficiently.
IS
Information System(s)

JAD
Joint Application Design is the concept of users and the information systems personnel designing the application together in facilitated workshops.

JRP
Joint Requirements Planning is the concept of users, business managers, business representatives, and systems expert re-designing the business process with information technology to identify requirements of the business process together in facilitated workshops.

MIS
Marketing Information Systems, Management Information Systems

Objectives
Those that need be completed at the end of an activity or a sub-process within the system development process.

Process
A process has boundaries through which inputs enter and outputs exit. A process consumes the inputs to produce outputs by performing a set of activities utilizing certain mechanisms as resources in a predetermined order based on specific controls and regulations.

Prototype
A prototype is a model of the newly designed information system. A prototype doesnot perform proper functions.

Quality
Focus on performing reliability, exhibiting fitness for use, tailoring solutions. One of the aspects of IS productivity identified by J. Dempsey et al.

Re-engineering
Is the fundamental and radical re-thinking of a process in order to re-design it to realise dramatic improvements in its performance.

Requirements

Those business process or application specific needs or expectations expressed by the business process representatives such as users, business managers and other functional representatives.

Requirements-Specifications
Detailed requirements specified by the users as expectations from the business process functions and information systems functionality.

Runaways
Projects which are not complete and are exceeding allocated resources. Resources may be time, money, size, or skills.

Specifications
Specifications are requirements that are written in a very detailed level from both a process and application specific viewpoint.

Speed
Focus on reduced time to business results, striving for a series of small successes. One of the aspects of IS productivity identified by J. Dempsey et al.

Tool Support
Tools or Tool Features that can be used in increasing the effectiveness and efficiency of an activity. These are the mechanisms or resources used by an activity or sub-process within a system development process in reaching the objectives.

User-Support
Is a function which provides users the necessary support in using the information systems. Support could be provided in operating the systems, trouble shooting the systems, in the form of training to use the systems.

Value
The worth of something measured in any form

Value-Adding
Anything which adds positively to the worth of a process. The positive worth may be in any form.

VITA

Sowmya Thiagarajan was born in Madras, Tamilnadu, India on May 6, 1969. She graduated from Sri Ramakrishna Mission Sarada Vidyalaya Higher Secondary School in Madra, India, in April 1986. She received Bachelor of Engineering degree in Computer Science Engineering from MadrasUniversity in Madras, India, in April 1990.

During the final year of study in Computer Science she worked as a Programmer Trainee at M. N. Dastur Engineering Consultant Co. in Madra, India between June 1989 and April 1990. She continued to work for the same company as a Programmer after her graduation from Madras University, until June 1991. She left the position to pursue higher studies in the United States of America. She joined the Industrial Engineering department at the University of Tennessee, Knoxville in Spring 1994. She worked as a graduate assistant in the department from May 1994 to May 1995. She is presently working as a Systems Analyst at Marketing Information Systems division of Philips Consumer Electronics Co. in Knoxville. Ms. Thiagarajan is also a member of the Phi Kappa Phi Academic Honor Society.

Her interests are in process structuring and problem analysis, strategic engineering and design of information systems, business process re-designs and modeling, and development of information systems.