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The effect of technology on information-based work systems

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THE EFFECT OF TECHNOLOGY ON INFORMATION-BASED WORK SYSTEMS

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ABSTRACT

Information technology managers face three perplexing issues; increased demand for services, rising costs, and an ever increasing rate of technological change. Coupled with this is an increased demand from senior management that all new expenditures show "bottom-line" oriented business value. In order to meet these challenges, most organizations have been spending heavily on information technology that will increase their internal productivity and thereby satisfy demand.

Despite these efforts little improvement has been achieved. In a recent issue of *Stage by Stage*, David P. Norton has written that information technology managers are being led by technology driven visions. This view has been applied in the place of sound management principles thereby leading to a misunderstanding of the appropriate role of technology and its effect in the work place. Technology is simply an enabler, with strategic benefits only occurring with a concomitant restructuring of the work environment. This thesis argues that failure to understand technological change and its relationship to information-based work systems is the root cause of the lack of productivity experienced by information technology managers.

This thesis proposes that two main components of an information-based work system, Technology and Organization need to

be aligned both internally as well as with each other for optimal productivity to be achieved: Technology and Organization. The technology component of an organization can be singularly modified as long as it does not introduce a conceptual change to the work system. Where a conceptual change is required, further changes are necessary in both the intrinsic technology paradigm of tools, techniques and methods, as well as the organizational components. In the latter, the organization must examine its interdependencies, coordinating mechanisms and organizational design components of structure, measurement and reward systems to ensure synchronization with new technological capabilities. Failure to recognize this factor can lead to both intrinsic and intercomponent misalignments resulting in an implementation failure and technological stagnation.

BACKGROUND

Four major trends facing corporations today in the use of information system technology are:

- Information technology is changing at an increasingly rapid rate.[1]

- Information technology is growing in importance to firms who are trying to gain a competitive advantage in their industry groups.[2]

- The cost of information technology related expenditures are rising.[3]

- Executive management is demanding more detailed information regarding the benefits of information technology investments.[4]

While almost everyone acknowledges the growing importance of information technology in formulating corporate strategy, this

understanding is coupled with a feeling of uneasiness about the benefits of such related investments.[5] These feelings of uneasiness are not unwarranted. John Dearden's famous 1972 article, *MIS is a mirage,* states that:

> "Computers and computer- related systems activities have been growing very rapidly, and currently the cost of these activities has become very significant in many companies. In spite of large expenditures, however, the quality of the information to management appears unimproved." [6]

This premise was extended by Mengele, who found that an increased investment in any determinant of information value (quality, quantity, or timeliness) did not always yield a comparable increase in information utility when measured as to the attainment of corporate objectives[7]. Indeed, Mengele found that often, an increase in one of the value determining factors led to an actual decrease of utility when applied to the management decision making arena[8].

This paradox of changing technology, rising costs, necessary new development and cost/benefit justification pressure coupled with uncertainty regarding the utility of information technology investments makes acceptance of this technology difficult for senior corporate managers.

While some MIS managers (as well as some technology vendors) like to spread a myth that the information technology related environment is too dynamic (complex) to lend itself to standard

management controls, Norton has claimed that the principles of good management are not being applied to the management of information technology.[9] He (Norton) suggests that MIS management is currently being dominated by technology-driven visions.[10] Organizations are rushing headlong into the implementation of new information technologies without much regard for their ability to either properly assimilate them or ensure that value is returned from them once implemented. Norton goes on to state that technology is only an enabler, and that strategic benefits do not occur unless dramatic restructuring of the work environment takes place.[11]

In Motion and Time Study : Improving Productivity, Marvin Mundel defines a model that allows for the successful introduction of technological change in a given work system [12]. While this paradigm has been successfully used in manufacturing and service related industries, the information service industry deals with a different set of component factors than those defined by Mundel. In this regard, a new paradigm that builds on Mundel's concepts may be required where information based technologies are concerned.

It is the intent of this thesis to define this new paradigm and to test its validity in both the information services environment.

INTRODUCTION TO THE PROBLEM

As previously mentioned, a new framework for the implementation of technology in an information based work system seems to be required. Mundel's work was primarly devoted to the enhancement of manual labor through the introduction of technology. In this regard, Mundel studied hand/body motions, product/part flow, etc... in an effort to optimize output.[13] In an information based work system, while technology remains the primary means by which labor is enhanced, the components of the labor as well as the material being transformed are radically changed. The main hypothesis of this work is that there are two main components of an information based work system that need to be aligned and optimized if effecient and effective production is to be achieved: *Technology and Organization.*

- Technology-

Most discussions of technology focus primarily on tools. This definition is only partially correct, and should include methods and techniques as well as tools. Therefore, a framework for the analysis of technology is offered whose objects of concern are tools, techniques, methods, concepts. The relationship of these objects form a Technology-Support grid which can be populated with specific attributes regarding each cell (see Figure 1).

TECHNOLOGY-SUPPORT GRID

TOOLS	TECHNIQUES
METHODS	CONCEPTS

Figure 1.

Specifically, each cell can be defined as follows:

- TOOLS. An instrument used in performing a task. A way increasing productivity through use of a machine or machine tool.

  Examples:

  Data Base Management System (DBMS)

  Computer Hardware

  4th Generation Programming Language (4GL)

A common attitude held by many organizations is that the procurement of an information technology (tool) in and of itself

solves the problems caused by mismanagement. Not surprisingly, this view is perpetuated by the vendors of information services and products who claim that "...we can now reduce everything we do to a number language to be acted on by machines" [14] . Indeed , as if possessed with some magical power , information technologies are expected to bring order out of chaos and provide policy where previously there had been a void . With this type of attitude espoused by technology vendors, its seems only logical to blame the technology itself when the implementation of a tool fails in the workplace. McFarlan and McKenney have found that when these situations occur, the organization tends to "disinvest" in the technology rather than to admit that the problems were caused by "... lack of management attention [or] incompetent project management".[15]

- TECHNIQUES. A specific way of accomplishing a desired task. Techniques can be manual automated. They (techniques) are normally used within the context of a methodology and may include the support a tool.

Examples:

Structured Analysis

Entity-Relationship Diagrammimg

Normalization

Quite often , in the information service environment, the use of a technique is mistakenly identified with that of a methodology. An example of this is the use of normalization in the design of databases.

Normalization of data is a technique that allows one to arrange fields into tables so that redundancy among non-key fields is eliminated. This technique does nothing to help you understand what those fields mean in the "business" or what those tables you just created are about. Normalization is a technique; it is not a methodology for database design. Therefore, after normalization , instead of simply having a mess among your data , (as is the case in most organizations) you now have a structured mess . Again, not surprisingly, this misuse of a technique is most espoused by technology vendors who claim that by using their product, which "automated the database design process" (simply performs normalization) , one can have a correct and efficient database design. Semantic problems are not addressed.

- Methodology. A body of methods, rules, and tasks employed by a discipline to accomplish a specific aim.

  Examples:

  SPECTRUM II

  Method I

  Stradis

While most MIS organizations officially claim to follow a methodology for systems development and implementation, few will claim that they are satisfied with the results obtained from its use. The reason for this apparent contradiction seems to be a desire on the part of most organizations to "follow the methodology" despite all evidence that the path they are following is the path to failure. Indeed, an organization's methodology its "way of doing business". In a functional area such as marketing, one would not hesitate to change strategy or policy if a more effective way of servicing the customer was found. Yet, in the MIS environment , this approach typically makes one a heretic instead of a hero.

During a recent conference on information technology held in Boston, Alvin Toffler stated that this last point was indicative of the bureaucratic form of the organization. This "go by the book " mentality is directly opposed to the innovative approach some companies are trying to adopt to gain competitive advantage. In this case, the organization in question may be its own worst enemy.

- Concepts. An abstract or generic idea.

  Examples:

  Database

  Data Driven

  Process Driven

  Data resource Management

While this is the easiest object in our paradigm to intellectually grasp, it is often the least understood. An example of this can be seen with the concept of database. Specifically, database is a concept premised on an inherent belief in the value of data sharing (among multiple application programs) and data independence (from application program control). Rarely do organizations carefully consider the full meaning and ramifications of implementing a new concept in the business environment. Often, the procurement of technology is seen as providing the desired benefits in and of itself.

What is necessary is to first understand the concept one is trying to implement, then, chose the proper methodology with the appropriate set of techniques and tools that will allow for the successful attainment of the anticipated benefits .

When the Technology-Support grid is populated with the specific attributes regarding an organization's tools, techniques, methods and concepts; structural discontinunities become readily apparent. As shown in Figure 2, the organization is attempting to implement the concept of database and has chosen a correct tool set in support of the concept, However, the chosen methodology and its associated techniques are inhibitors to success since they were designed to support different concepts (stand alone applications) and technologies (traditional file structure approaches). Hence, they stand in the way of the organization's attempt to attain the full value regarding its information technology investment.

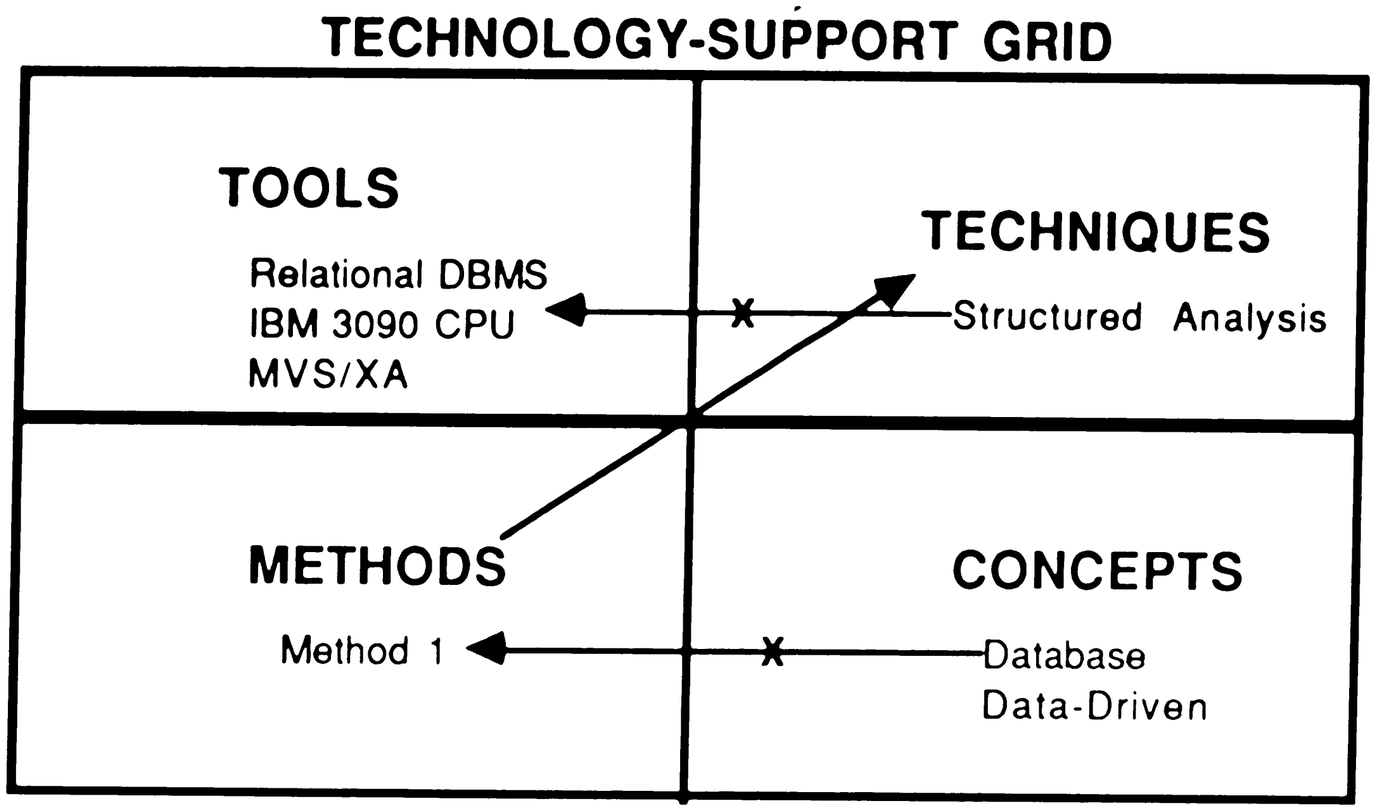


Figure 2

An example of an effective alignment is shown in Figure 3. As can be seen, the attributes of each cell are chosen so as to allow for conceptual harmony to exist throughout grid. It should be noted that as in Mundel's paradigm, a change in any attribute of any individual cell may cause a misalignment with regard to the other cell attributes. This misalignment, if not understood and corrected could cause an implementation failure leading to technology stagnation. Once this situation occurs, McFarlan and McKenney have found that it is usually two years before the organization begins to reinvest, often with a complete change of personnel.[16]

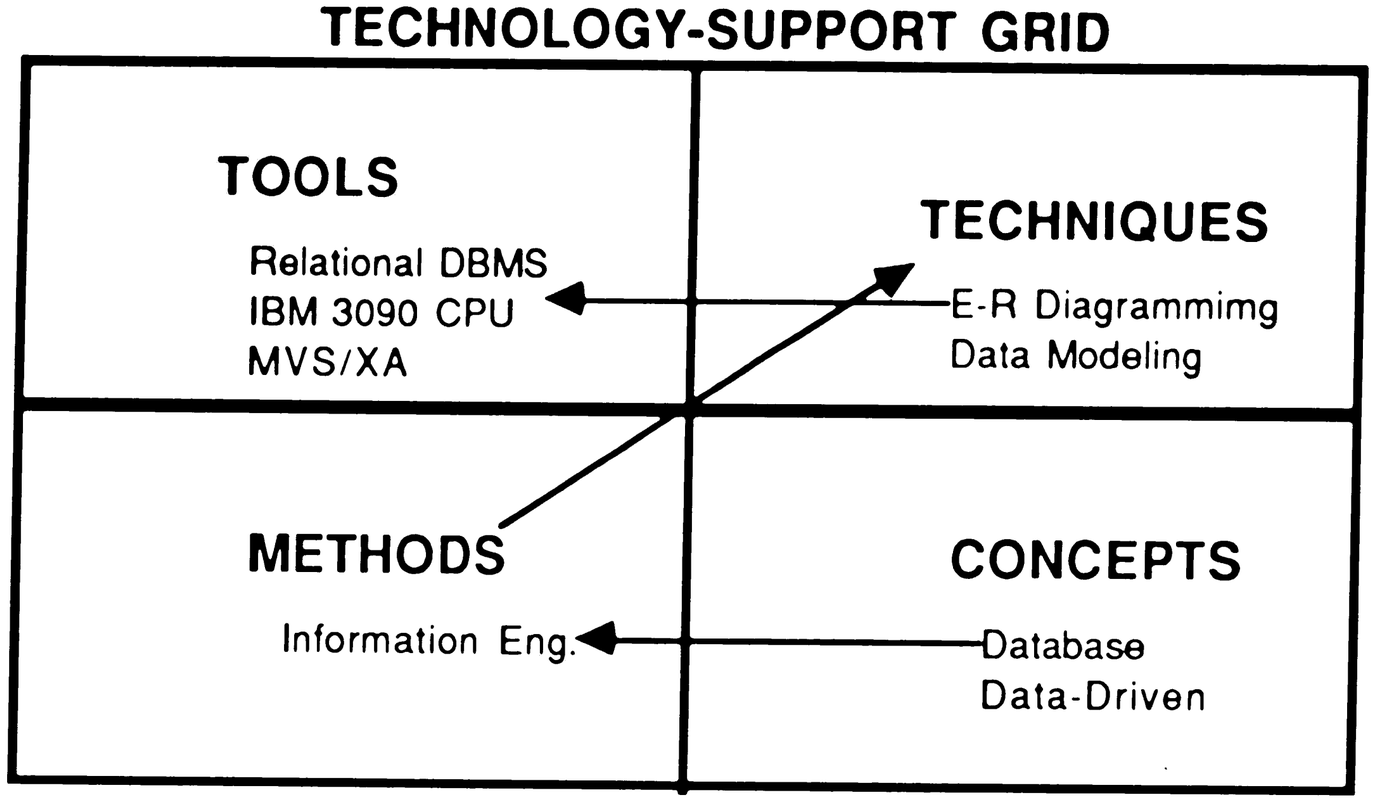


Figure 3.

- Organization-

Much work has been done in the area of organizational design. In an effort to describe the interpendencies among work groups, James D. Thompson described three types of activity coupling: pooled, sequential and recriprocal.[17] Pooled coupling occurs when activities are basically independent of each other except for a sharing of resources. Pooled coupling involves little interdependence and hence, little need for coordination. Sequential coupling activities are performed serially fashion and require moderate interdependence at an interface level. Being in series lends itself to coordination at the output/input level thus causing major problems if some activity

malfunctions. Recripocal coupling is the most interdependent with some activities acting as feedback and control nodes. This form of interpendence lends itself to the most complex activities and hence requires a great deal of coordination among its workers.

Mintzberg sees an organization as being composed of two fundamentally opposed tasks; dividing work into tasks that need to be performed, and coordinating those tasks to accomplish the mission of the enterprise.[18] In order to achieve this, Mintzberg describes five coordinating mechanisims that are most commonly used: mutual adjustment, direct supervision, standardization of the work process, standardized outputs, and standardized skills. His basic premsis is that as organizational work grows in complexity, the enterprise moves from mutual adjustment between workers for coordination, through direct supervision, and into standardization of process, output and skills, in that order. [19] If complexity continues to grow, the organization is forced back into a phase of mutual adjustment.

Mintzberg describes the five configurations of organizational form that an enterprise can take: Simple Structure, Machine Bureaucracy, Professional Bureaucracy, Divisionalized Form and Adhocracy.[20] The Simple Structure is very non-structurally oriented and is characterized by high centralization of power, a loose division of labor and minimal use of planning, training, and liaison devices. Usually found in smaller size organizations, the Simple Structure relies on direct supervision to accomplish its coordination of work

activities. The Machine Bureauacracy is a highly specialized organization with very formalized procedures. The division of labor is characterized by strong distinctions between both departments and line and staff functions. Machine Bureaucracies tend toward the use of standardization of the work process as the main coordinating mechanism.

Professional Bureaucracies are highly decentralized in structure and rely on standardization of skills as their major coordinating mechanism. In this regard, they tend to rely on training of the incumbents with little direct supervision. They are comprised of professionals or functional specialists who are more dedicated to their profession than to the organization they serve. Power tends to be decentralized, giving workers extensive autonomy with little need to coordinate among peers.

In the Divisionalized Form, power is given to quasi-autonomous groups to run their own activities. This configuration relies on standardization of output for its main coordinating mechanism, and tends to drive its units to Machine Bureaucratic form. While distributing operating authority to its divisions, this configuration maintains centralized control over such items as overall financial resources and strategic decision making. It also tends to provide certain support services to the various divisions.

The Adhocracy is an organization with little formalization of behavior that tends to deploy its specialists in small multidisciplinary project teams. Power is distributed to its

members. This form lends itself to environments of increasing complexity with technical systems that are becomimg more sophisticated and highly automated. The major form of coorination in an Adhocracy is mutual adjustment.

In another view, Kotter, Schleshinger, and Sathe discuss the elements of an organizational design as representing a proper "fit" among the design components (structure, measurement system, reward system, selection and development and development systems), tasks, and people.[21] For the purpose of this analysis, the elements of interest are structure, measurement systems and the reward system. Kotter views the organization as being comprised of sub-units which are in turn comprised of jobs that are assigned to people. Jobs are designed around tasks and carry with them formal rules, procedures and goals. Measurement systems are designed to influence the behavior of the people assigned to jobs by developing and disseminating information on the nature of their progress in carrying out assigned tasks. These can take the form of productivity reporting, standard cost systems, or performance apprasial systems. Reward systems are designed to induce people to work toward measured oblectives and are closely tied to measurement systems. Common organizational rewards include money, fringe benefits and promotions.

How these factors are linked together in a dynamic sense (i.e., "fit") determines an organization's success. For example, If an organization is structured along functional lines and measures

employees on their ability to perform cross-functional projects, yet rewards them on their ability to support a single functional area, this is a lack of "fit".

The concept of "fit" is quite useful and can be extended to the three organizational issues discussed so far: interdependency, coordination and organizational design. In this regard, a work system that shows a high degree of interdependency would require a coordinating mechanism that ensures a high degree of communication. These two factors woud then be required to have the proper "fit" intrinsically among organizational design elements to ensure proper functioning. Any misalignment among the components would cause the system to malfunction and possibly fail.

The linkage between technology and organization is the work-system. It is the means by which the organization accomplishes its mission through the use of people and technology. In an information-based environment, the work-systems primary mission is the processing of information itself. A prime example of such a situation is the data processing or information services environment. In this work-system, the units are primarily charged with developing information products (i.e. programs, application systems, etc....) that provide information about the state of some business activity for one or more using entities. The traditional work-system for this effort has been described as the "waterfall" approach (see Figure 4.), beginning with user requirements and cascading to completion through preliminary design, detail design,

programming, testing, and implementation. This basic "job-shop" approach requires that each new system undergo the same steps of analysis and design, often recreating the same data and programs for only slightly different uses. The technology (tools, techniques and methods) support independent development efforts with little sharing of data or application code being sought. The organizational attributes of such a situation yield a sequential interdependency between various task of design and development, with standardization of the process being the main coordinating mechanism. The organizational design elements tend to show a structure broken down between analysis, design, and programming responsibilities, with the measurement and reward systems being similarly focused.

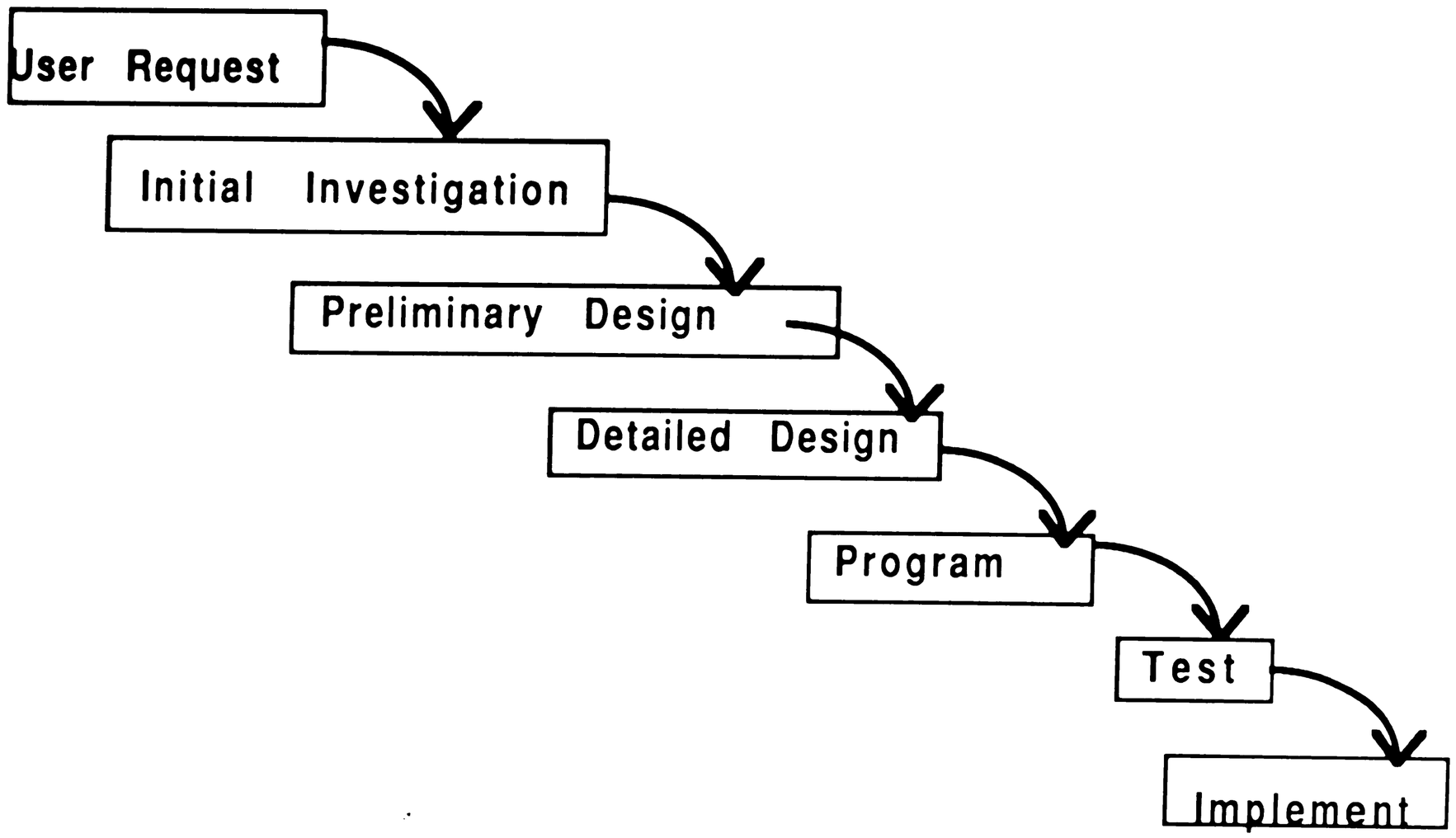


Figure 4.

While this process seemed to work through the 1960's, during the mid-1970's an explosion in the demand for information has increased to where the productivity of the information developers needs to rise by two orders of magnitude in order to meet it.[22] This situation has led to technology vendors delivering products that promise to improve productivity by reusing the two basic components of information products: data, and application code. To accomplish this, vendors have been providing products that have dramatic effects on work-systems. For example, in order to accomplish the sharing of

data, database management systems (DBMS) and data dictionaries have been introduced. These tools, as previously mentioned, also require a different set of techniques and methods since the concept of development changes. This conceptual change is reflected in the work-system through a necessary change from a sequential to a recipricol interdependency using mutual adjustment as a coordinating mechanism with appropriate changes in the organizational design elements. When such changes are made, organizations can experience dramatic improvements in productivity. When such changes along both dimensions are not made, the opposite can occur often resulting in the failures mentioned by McFarlane and McKenney. [23]

STATEMENT OF THE PROBLEM

The main hypothesis of this work is that information technology dramatically affects information intensive work-systems. In this regard, it not only affects tools, techniques and methods, but when a conceptual change is introduced, it also effects the organizational dimension of interdependencies, coordinating mechanisms and organizational design elements. It is the failure to understand the nature of these required changes that often leads to failure.

Study Environment

Background

XYZ Company, A subsidary of XYZ Inc., is a major producer of consumer products. The company is organized along traditional functional lines with a division president to whom report vice-presidents for manufacturing, marketing, sales, new business development, technical (engineering) finance/administratiion, and human resources (see figure 5).

The Information Services department reports to the vice president of finance and administration, and is comprised of 100 employuees in the areas of business systems development, technical services, computer operations, and communications services. The department is charged with supplying information technology support to non-plant systems efforts. In this regard, the plants (which fall under the auspices of the vice-president of manufacturing) have their own computing facilities for process control operations. They do use the services of the Information Services group for plant administrative computing support, however.

To accomplish its mission, Information Services understands its key success factors as:

- Minimization of system down time

-The stated goal of I. S. management is to provide 99% system availability. This is required due to the fact that the XYZ Plant (the largest of eight manufacturing facilities) utilizes the central I.S. mainframe computer to support its non-process control systems.

- Delivery of reports on-time

- Report delivery is scheduled at various times during the day as well as after hours. Any report not being delivered on-time due to either a software or operational problem is viewed as a major service failure by I. S. management.

- Expeditious development of information requirements

-Insofar as no official systems development capabilities exist in any other departments, the Company relies solely on Information Services to supply its information technology needs. in this regard, Information Services management feels that it is imperative that all systems development schedules be met according to agreed upon time frames with the sponsoring functional areas.

- Containment of information technology costs

- As is generally the case, informaton technology costs have been taking up an increasing proportion of the Company's administrative/overhead budget. Through effective hardware capacity planning, Information Services management is attempting to limit budget expenditures.

Relationship to Overall Division Strategy

The XYZ Company is basically the cash producer of XYZ Inc. the Division's stated goals are to :

• Increase Market Share

- In its industry segment, over 80% of the market is controlled by either XYZ or its largest competitor. In this mature environment, XYZ Inc. is the overall leader. It plans to maintain its lead through both new product developement as well as growth in core brands. In order to support this, Business Systems Development has had to dramatically increase its efforts in the sales, marketing, and marketing research areas. This has also required the procurement of new hardware and software to support what are basically end user analysis systems. This has also caused Information Services in general, and Business Systems Development specifically, to change its normal role of being a central provider to one of providing the technology and sharing some development responsibilities with the end user community.

• Grow by Aquisition

- Over the past five years, XYZ Company has acquired and assimilated two smaller companies and the north american operations of a major competitor. XYZ's strength in its distribution channels, as well as its ability to perform sales and marketing on a national basis, has enabled it to take strong regional brands and

transform them into national products with high visibility. This has had dramatic effects on the Information Services department, especially Business Systems Development. In this regard, the group has had to assimilate new sales, marketing,distribution and financial information into its systems causing a complete revamping of its data structures and reporting requirements. Also, the required assimilation had to be completed on an emergency basis causing all normally scheduled work to queue, thereby increasing the group's work backlog. In addition, no representatiive from Information Services is included on the aquisition team, thereby precluding any pre-planning that may better enable the assimilation process. In addition, no short term staff additions (including contract help) have been permitted.

• Become the Industry's Low Cost/High Quality Producer

- As its basic competitive strategy, the Company is investing heavily in computer-integrated manufacturing technology (CIM) in an effort to further reduce the cost of production. All associated systems activities are carried out by the manufacturing engineering group which reports to the vice president of manufacturing. Information Services and Business Systems Development plays little role in this effort.

• Avoid being a technological leader

- While investing heavily in technology to become a low cost producer, the division has stated that it does not wish to pioneer any technology and assume the asociated risks. This philosophy has been

less successfully applied to the Information Services department.

Technology

The technology aspect of the Business Systems Development group within Information Services department can be understood by viewing three components; tools, techniques, and methods.

- Tools

Hardware - XYZ Company is primarily an IBM shop with regard to its non-plant computing operations. The major component of this operation is an IBM 3081 Model D providing 15 millions of instructions per second (MIPS) of processing power. In addition, a second mainframe computer, an IBM 4081 Model Group II providing 6 MIPS, is also being used to support an information center concept where an end user can perform some of their own elementary data retrieval and manipulation. This approach was instituted as a stop gap measure to what management viewed as an uncontrolled proliferation of personal computers into the work environment.

Software - Being primarily an IBM shop, all systems software is also of IBM origin. The primary operating system is IBM's MVS/XA which provides 14 megabytes of addressable space which can be utilized by application software. A special security software package ACF-2, from Cambridge Associates is used to protect certain payroll files and other data deemed to be confidential in nature. Application software is mixed between in-house developed and purchased application "packages". Generally, with the exception

of the payroll/personnel, human resource and financial functions, all major application software has been designed and written by in-house personnel. Underlying many of the new application is a database management system (DBMS). This package, SUPRA, in a non-IBM product and was procured from CINCOM Systems. The role of this software tool is to manage the data independently of the applicatiion programs, thus creating both a shared resource and a centralized management of data function.

Methods and Techniques - The major systems development methodology followed by Business Systems Development is called SPECTRUM II. This methodology covers the entire range of systems development from initial requirements to testing and implementation. While this standard approach works for most traditional applications development projects, the group also follows a different methodology for the data base system projects which are making up an increasing amount of the total work effort.

Organization

As previously stated, the Information Services department consists of 100 employees spread among four groups: Business Systems Development, Computer Operations, Technical Services and Communications Services. The main focus of this analysis is Business Systems Development which is comprised of 42 personnel spread among four Business Applications units which mirror the functional area groupings, and Data Administration (see Figure 6).

Business Applicatiions-

The Business Applications Area is divided among four units that support the four main functional areas of the Division; Logistics, Finance/Administration, Manufacturing and Sales/Marketing/New Business Development. Each area is comprised of eight analysts and one area manager. The analysts are are divided between positions of business systems analysts and computer systems analysts. The areas are primarily responsible for utilizing the Company's information technology to enhance the operation of their supporting functional area departments. Their overall mission is to enhance the value of the functional area operation by bringing the power of computing technology to bear on organizational problems.

•Business Systems Analysts- Presently, each area has at least one business systems analyst who is primarily responsible for working with the end user analysts on the design of information systems. They are also responsible for determining how information technology can be utilizeed to help the functional areas achieve its objectives. In this regard, the business systems analysts translate these requirements into specifications for application systems that can be utilized by the computer systems analysts in developing working applications. They also assist the data administration analysts in the preparation of information and process models that reflect the business environment.

Values and Norms - Generally, the business systems analysts view

themselves as significantally more business than technically oriented. In many cases, business analysts have moved into the functional area environments rather that remaining in the Information Services department.

• Computer Systems Analysts- The Business Applications areas are mainly comprised of computer systems analysts whose main function is the development and maintenance of application code, The unit is primarily technical in nature and skill requirenments are based on knowledge of the IBM technical hardware/ software environment. In this regard, the computer systems analysts are computer language specialists and have little knowledge of the business environment and relatively little contact with the end user analysts.

Values and Norms - Being primarily technical in nature and having little contact with the user environment, the computer systems analysts tend to develop a technical culture that can be seperate and distinct from from that of the rest of the division. they tend to view the technical environment as paramount and at times believe that the business should adjust itself around the technical constraints.

Data Administration - This area is charged with maintaining a "company-wide" view of data as opposed to creating applications for any particular functional area. In this regard, the area is charged with creating and maintaining a shared data resource which can be utilized by multiple applications and functional areas. This approach has the benefit of providing both consistency of information as well as lower development and maintenance costs. In order to accomplish

these objectives, the area reviews all application development plans submitted by each functional area and recommends alternative actions based on optimized data resource development. In addition, the group maintains the Company's DBMS software.

•Data Administration Analysts- The Data Administration Analysis unit is primarily responsible for the developemnt and maintenance of information and process models that are reflective of the business environments. It is from these models that physical data structures and application code are developed. The output from the modeling process is stored electronically in a data catalog and made available to both end user analysts and computer systems analysts.

Values and Norms - The members of the unit are more inclined to be business than technically oriented and has an overall desire to provide architecturally oriented solutions to functional area problems.

• Data Base Analysts- The basic responsibility of the Data Base Analysis unit is the design, development and maintainence of physical data structures that reside on the Company's DBMS software. This software serves the needs of both the end user community (for query purposes) and the computer systems analysts for the application development process. To accomplish its mission, this primarily technical unit mainly interacts with the data administration analysts and designs the physical data structures to reflect the models of the business environment.

Values and Norms - Being primarily a technical unit, the group believes it adds the most value when its designs optimize the performance of the DBMS software. In this regard, the units members tend to be technocratic and place paramount importance on the working of the software, at times over that of the business.

Structure-

Business Applicatications - The Business Applications areas are structured between two distinct units: business systems analysis and computer systems analysis .

•Business Systems Analysis- The business systems analysts follow a two step career ladder of business system analyst and senior business system analyst. The main distinction between the two levels is the amount of time spent on the job and the level of end user contact and client development that is expected on the part of the senior business systems analyst.

•Computer Systems Analysis- The computer systems analysts have a four step career ladder of associate computer systems analyst, computer systems analyst, senior computer systems analyst and lead computer systems analyst. The primary distinction among the job levels is the amount of supervision and the amount of design work that is attained as one moves up to progressively higher levels.

Data Administration - The Data Administration area is structured between two distinct units: data administration analysis, and data base analysis.

•Data Administration Analysis- The data administration analysts have a three step career ladder of associate data administraton analyst, data administration analyst, and senior data administration analyst. The main distinction among these levels is the amount of abstraction in modeling that is expected and the level of contact with the end user environment. In many ways, the data administration analysts resemble the business systems analysts in in their business outlook and overall job responsibilities.

•Data Base Analysis- The data base analysts have a three step career ladder of associate data base analyst, data base analyst, and senior data base analyst. The associate data base analyst is primarily charged with the mainteinance of existing data base structures. The main difference between the remaining two job classes is the level of design work and the amount of control over all aspects of the DBMS software (including upgrades to new releases). In this manner, the data base analysts are a cross between the computer systems analysts and the systems software analysts who reside in the Technical Services group.

Measurement and Reward Systems-

Business Applications - Both units of the Business Applications areas are measured by a yearly Management by Objectives scale (MBO) that is negotiated with management in Janurary of each calander year. The reward system is is based on a combination of

percentage raise possibilities set by Company personnel and the employees position within a quintile salary range. The budgeting for this is performed during July of each year during the annual budget cycle with the administration being performed on the employee's anniversary date. Each job grade is measured and rewarded as follows:

Business Systems Analysts -

• Senior Business Systems Analysts are measured and rewarded on their ability to enhance the functional area environment through the application of information technology. In this regard, they are measured by their ability to determine creative solutions to business problems and by their ability to to perform overall project management and coordination functions. This is usually concerned with the development of some major application. They are rewarded more for their ability to deliver projects within the specified time frame than for their ability to devise creative solutions.

•Business Systems Analysts are measured and rewarded in the same manner as the senior business systems analysts with the major exception being the scope of ttheir efforts. The business systems analysts will usually not be charged with the development and coordination of a major application, but with a major subsystem or a minor application. They are closely supervised by the senior business systems analyst and are rewarded for their ability to meet project schedules.

Computer Systems Analysts -

•Lead Computer Systems Analysts are measured and rewarded for their ability to provide effective technical advice to multiple application coding projects. As lead analysts, they are more inclined to serve as consultants to major development efforts on both the techninal and language aspects of the coding process. In this regard, they may not be concerned with the actual coordination and delivery of major coding efforts. They are mostly rewarded on their ability to help resolve technical problems in an efficient manner.

• Senior Computer Systems Analysts are measured and rewared for their ability to deliver working applications as determined by the project schedule. They are typically assigned to major applications and usually coordinate a team of lower level analysts in this effort. To accomplish their mission, they must coordinate all phases of the development process from coding through to testing and implementation. They are rewarded on their ability to accomplish this within the project schedule. Quality, while an important issue, is secondary to BSD management. Their main interaction is with the business systems analysts and the data base analysts.

•Computer Systems Analysts are measured and rewarded for their ability to deliver major components of of working applications. They are usually directly supervised by the senior computer systems analyst and are rewarded for their ability to meet project schedules.

•Associate Computer Systems Analysts are basically involved with the maintenance of current application code. They are directly supervised by the computer systems analysts and are measured by their ability to carry out assingments as directed. They are rewarded in the same manner.

Data Administration - As with the case of the business systems analysts, both segments of the Data Administration area are measured by a yearly MBO that is negotiated in Janurary. The reward system is based on a combination of percentage possibilities set by Company personnel and the employees position within a quintile salary range. The budgeting for this is performed during July of each year during the annual budget cycle with the administration bring performed on the employee's anniversary date.

Data Administration Analysts -

• Senior Data Administration Analysts are measured on their ability to produce effective data resource development plans that both accurately reflect the business environment and optimize the application development plans around the data resource. Senior data administration analysts also review the data and process models produced by the data administration analysts for quality and integrity. They also serve as consultants to the business systems analysts and the data base analysts on the modeling techniques and methods used to produce information from the models. They are rewarded on the quality of their work as opposed to any on-time delivery pressure.

•Data Administration Analysts are measured on their ability to produce accurate models of of the businesss environment as perscribed by the methodology. Their work is closely reviewed by the senior data administration analysts with all documentation being stored in the area's data catalog. They are also rewarded on the quality of their efforts as judged by the ability of the Business Applications areas and the end users to retrieve accurate information about their environments.

•Associate Data Administration Analysts are primarily responsible for maintaining the area's data catalog. They are measured by the ability of a user to easily retrieve accurate information as specified by the data administration analysts. They are also rewarded on the quality of the interface to the catalog and the amount of customer saatisifaction they attain. They are closely supervised by the data administration analysts.

Data Base Analysts -

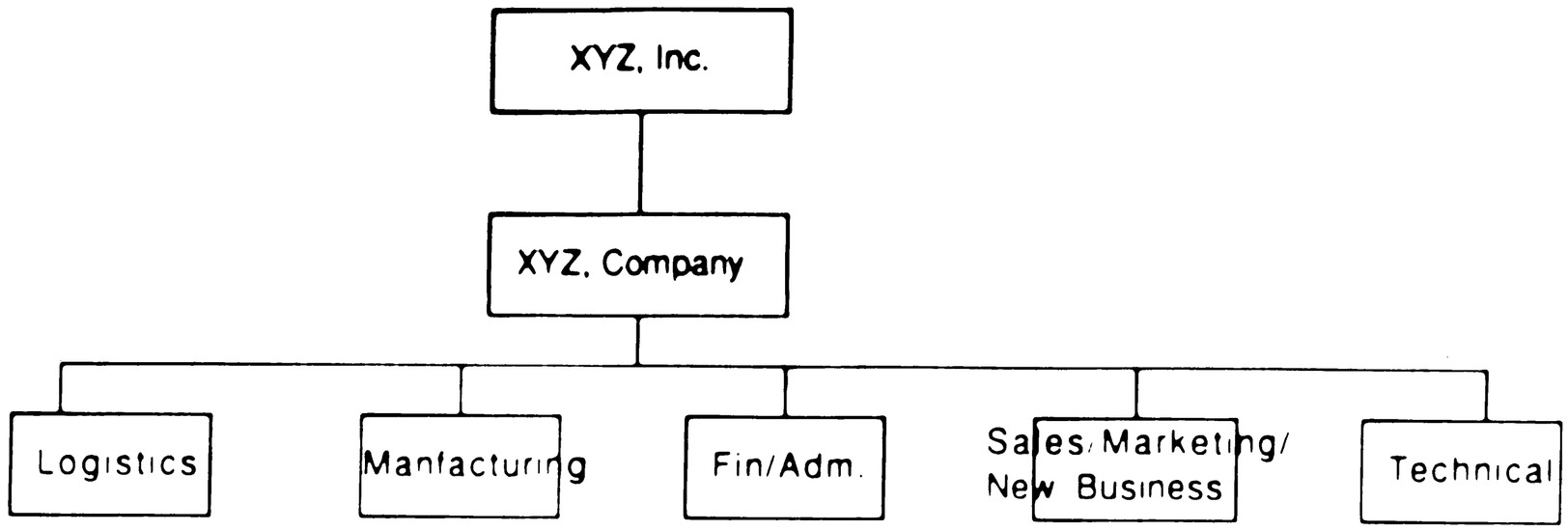
• Senior Data Base Analysts are measured in their ability to optimize DBMS software performance. They also have responsibility for reviewing all physical data structure designs produced by the data base analysts. They are rewarded on the factors of system performance and integrity. They mainly interface with senior computer systems analysts during the design phase of an application project.

•Data Base Analysts are measured by their ability to design physical data structures that accurately represent the information

models produced by the data administration analysts. They are rewarded on the quality of their efforts as determined by the software's ability to consistently produce accurate information.

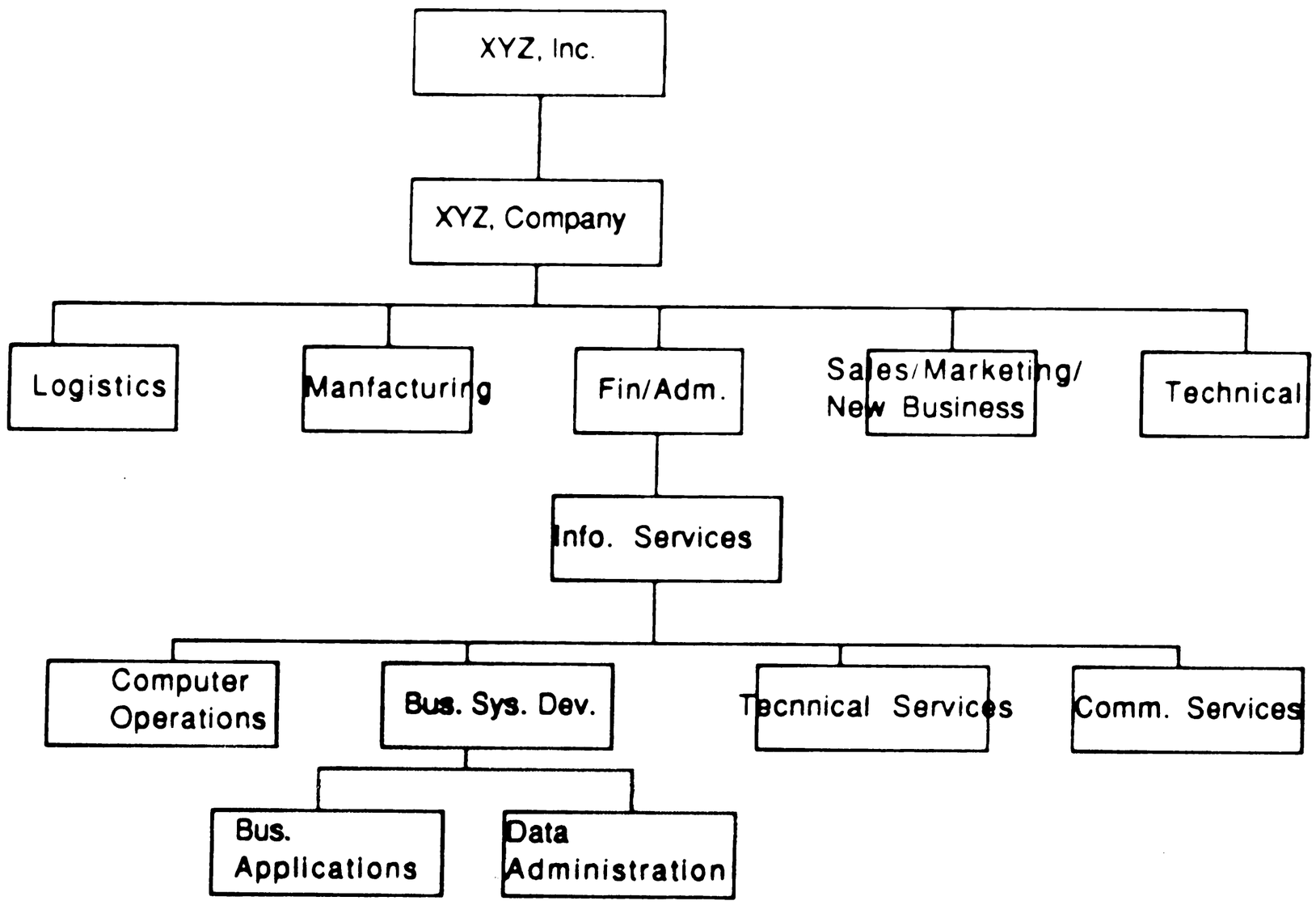
•Associate Data Base Analysts are primarly concerned with performing mainteinance transactions on existing structures. In this effort they are closely supervised by the data base analysts. They are rewarded on their ability to efficiently complete efforts without any errors.

XYZ Functional Structure



(Figure 5)

XYZ Company, Information Services Structure



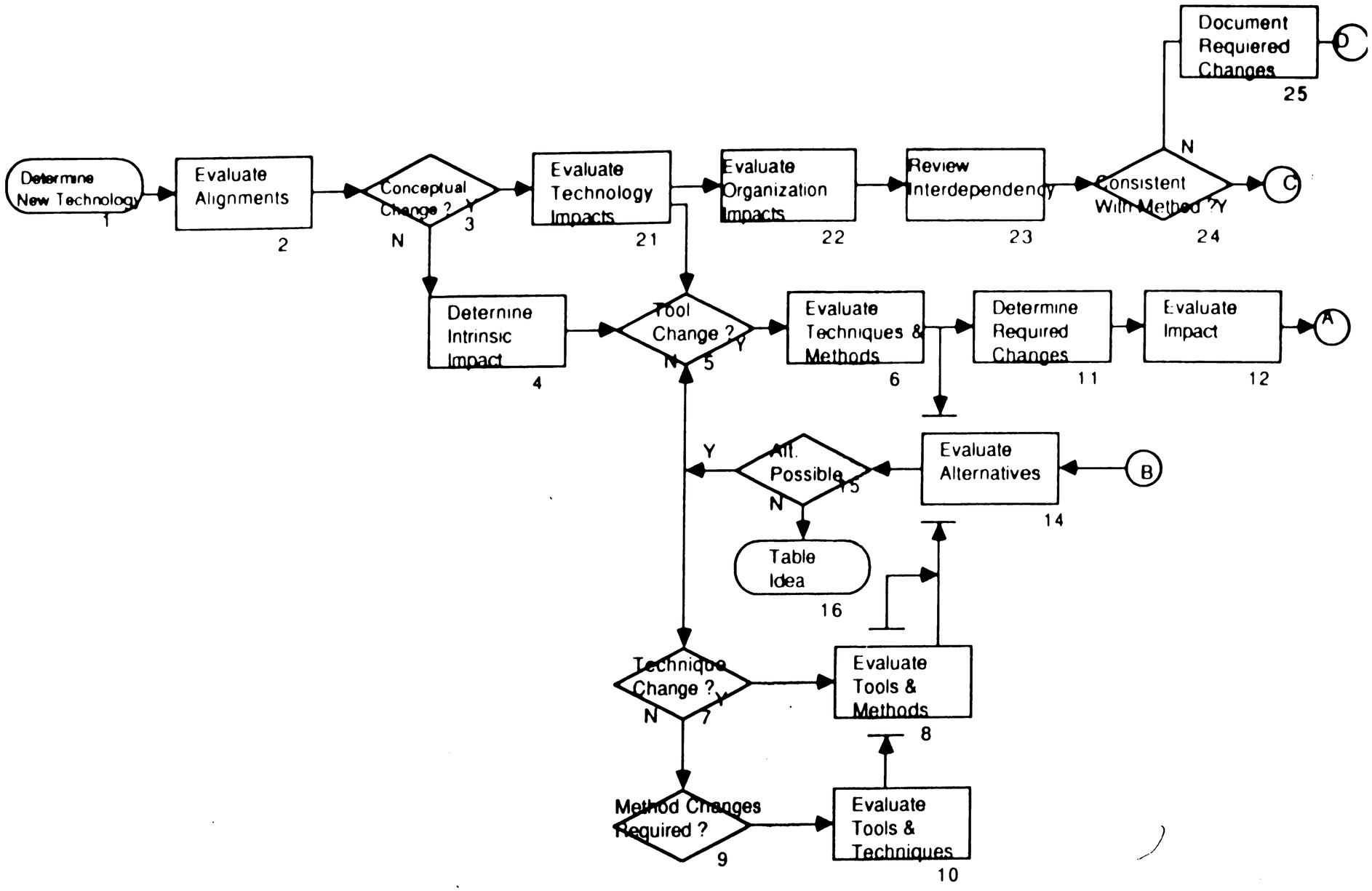
(Figure 6)

DESCRIPTION OF THE MODEL

As stated previously, the major hypothesis of this thesis is that there are two main components of an information-based work system that need to be aligned both internally as well as with each other for optimal productivity to be achieved: Technology and Organization. The technology component of an organization can be singularly modified as long as it does not introduce a conceptual change to the work system. Where a conceptual change is required, changes are necessary in both the intrinsic technology paradigm of tools, techniques and methods, as well as the organizational components. In the latter, the organization must examine its interdependencies, coordinating mechanisms and organizational design components of structure, measurement and reward systems to ensure synchronization with new technological capabilities.

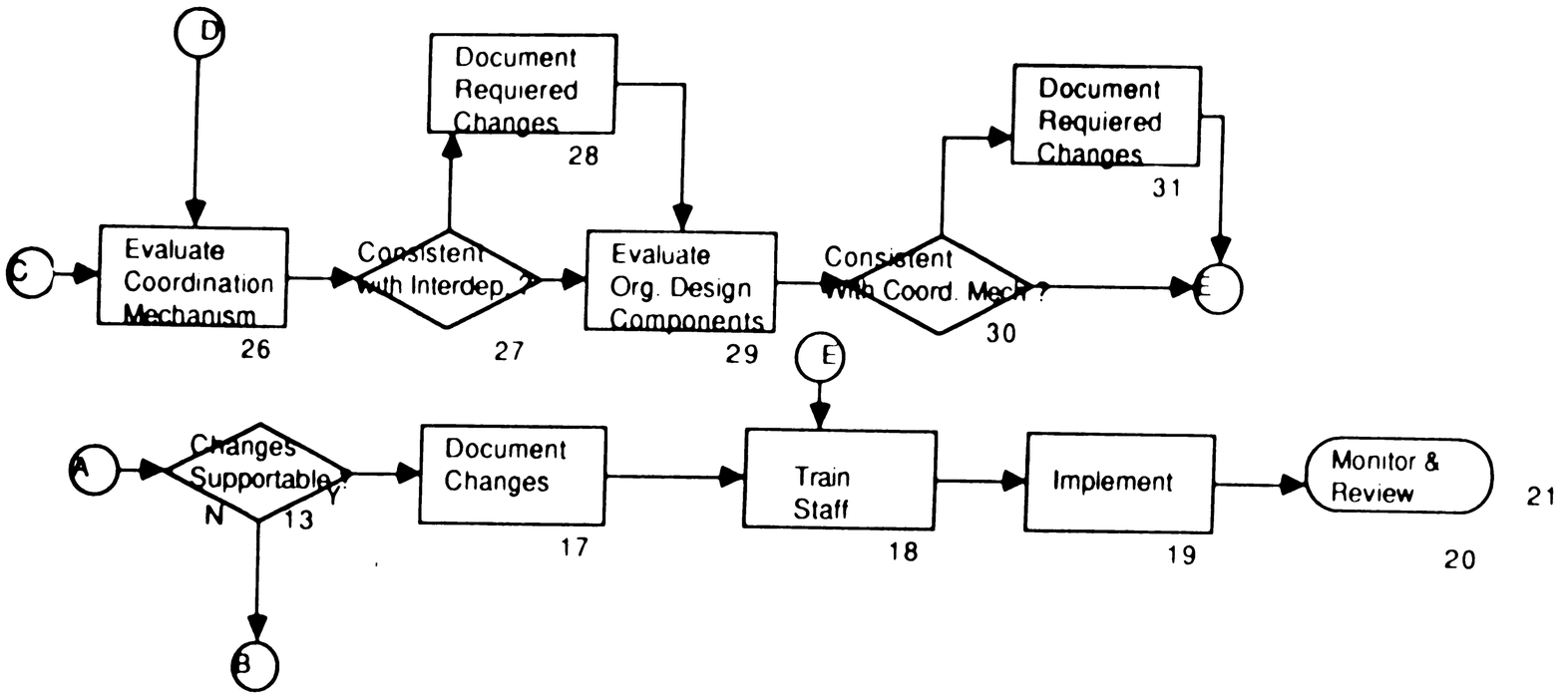
Technology - Organizational Change Model

Figure 7.



Technology - Organizational Change Model

Figure 7.



Block Diagram Descriptions

1. In each situation, a new technology is first identified that is hoped to have some direct benefit to the work system in question. It is assumed that some type of decision analysis has been used.

2. Once the decision has been made, the implementors should evaluate the existing work system and appropriate alignments to determine what potential areas will be effected.

3. The first major question that must be answered is whether the new technology constitutes a conceptual change to the current work system. In this regard, the implementors need to determine whether the new technology requires the implementation of a totally new concept or whether it is simply another way of performimg some already defined task.

4. If the answer is no, the unit can assume that the implementation will require only intrinsic technology changes and therefore organizational implications can be ignored.

5. The first evaluation step concerns tools. An example of this can be the decision to implement a new database management system or teleprocessing monitor.

6. If the answer to the above step is yes, an evaluation of supporting techniques is required. In this regard, if the tool is a data structure reverse-engineering tool for example, conceptual data modeling techniques are required.

7. The next possible change in the work system is one of techniques. The implementors should review the technique portion of the departmental technology profile to determine the appropriate impacts.

8. If the change is not tool but technique oriented, the implementors need to determine how the techniques enhance the value of the tool or methodology in use. In this event, both tool and technique need to be evaluated in order to ensure proper alignment.

9. The last intrinsic change possibility is that of a methodology. This in essence is the description of the entire work system. Any change made here will by necessity affect all other components.

10. If the change is methods oriented, the implementors needs to evaluate the inventory of both tools and techniques to determine if proper alignments are in order.

11. After the evaluation of all intrinsic steps the next activity is to review the changes that are required to the existing paradigm.

12. Once these changes have been reviewed, their impact on the overall technology paradigm needs to be evaluated.

13. The main question that should be asked, is "Are the proposed changes supportable"? In this regard, the implementors need to question both their internal cultural situation as well as the overall competitive strategy of the corporation.

14. If the change is not supportable, given the other factors in the paradigm or due to the competitive strategy of the corporation, the unit should evaluate other solutions. Possibly the second place item in the decision analysis might provide a better alternative.

15. If an alternate solution is found to be possible, the implementors should repeat steps 5 through 13 for the new alternative.

16. If an alternate solution is not found to be possible, the potential change should be cancelled.

17. If the changes are supportable, the implementors should ensure that all changes are documented into the appropriate information repository.

18. Once changes have been documented, the staff needs to be trained in the new tools, techniques or methods. It should be noted that this activity can take place through either a formal training class, or something informal such as a newsletter or department bulletin.

19. Once the change has been fully communicated, the final step is implementation. This should take place through a well detailed schedule with conversion dates listed.

20. After Implementation is complete, the unit should monitor the change and review the expected results against the proposed benefits or expectations. A full post -implementation review or audit of the technology should be performed .

21. If a conceptual change to the work system is required, along with all changes to the intrinsic technology area, the unit must also evaluate the organizational implications of the proposed change.

22. The first step in the organizational review is the determination of the current organizational profile. The unit should have a detailed list of the work group interdependencies, coordinasting mechanisms and organizational design components.

23. The first organizational analysis step is the review of the interdependencies between tasks in the work system.

24. The key intersection between the technology and organizational profiles is the link between the methodology and the work system - task interdependencies. The interdependency selection must coincide with the appropriate form of task coupling as indicated by the methodology.

25. If the work system - task coupling and the interpendencies are found to be inconsistent, changes to the interpendencies must be documented.

26. After evaluation of the interpendencies, the proper coordinating mechanism must be identified.

27. The coordinating mechanism must be reviewed for consistency with the task interpendency that is reflective of the methodology.

28. If consistency is not found, appropriate changes must be documented.

29. The final phase of the organizational analysis consists of evaluating the organizational design components. In this regard, the structure of jobs must be evaluated as well as the measurement system, reward system, and selection and development systems.

30. The main question here is the consistency of the organizational design components with the coordinating mechanisms. In this regard, the incumbents of affected jobs must utilize the appropriate coordination mechanism. The measurement and reward systems must reinforce the effective communication among the appropriate positions.

31. If the above is found to be inconsistent, appropriate changes must be documented to ensure proper alignment.

EXPERIENCE WITH THE MODEL

The model described on the preceeding pages was developed through experiences at XYZ Company. In 1986, XYZ was recgonized as an international "showcase account" by a vendor of relational database management software. This is quite ironic since their first attempt at introducing the vendor's product was an unmittigated disaster. After 2.5 years of effort, the first database information system attempted had to be scrapped. What was learned from the experience had more to do with the ways to introduce technology into a work system than it had to do the proper way to build database information systems .

Prior to the introduction of database technology, XYZ exhibited the following technology profile (see Figure 8):

Tools-

Hardware-IBM 3081

Systems Software- MVS , CICS, VSAM Files

Techniques-

Traditional systems analysis and design techniques of output design,input design and file design.

Methods-

SPECTRUM Information System Design Methodology.

Concepts-

Traditional information systems development.

TECHNOLOGY PROFILE
PRE-1981

Tools	**Techniques**
VSAM Files	Traditional Systems Analysis
Methods	**Concepts**
SPECTRUM	Traditional Information Systems Development

Figure 8.

This is a classic third generation profile that exhibits good internal alignment among tools, techniques, methods, and concepts. The tools support stand alone file development that is designed to serve a single use. This in turn is supported by the techniques of traditional systems analysis. The methodology is designed as a series of sequential processes which finally deliver an information product for an end user.

Organizationally, XYZ had the following profile (see Figure 9):

Interpendency-

Sequential coupling.

Coordinating Mechanism-

Standardized Work Process.

Organizational Design Components-

Structure-

Traditional systems development functional orientation yielding systems analysis (Business Systems Analysts) and programming (Computer Systems Analysts).

Measurement and Reward Systems-

Yearly Management by Objectives (MBO) system measuring and rewarding personnel for completing assignments on time within the parameters set by the specific projects following the SPECTRUM methodology. Business Systems Analysts are measured and rewarded for performing the initial investigation and design phases of the methodology . The computer systems analysts are measured and rewarded for developing effective application code within the specifications set by the business systems analysts.

ORGANIZATIONAL PROFILE
PRE-1981

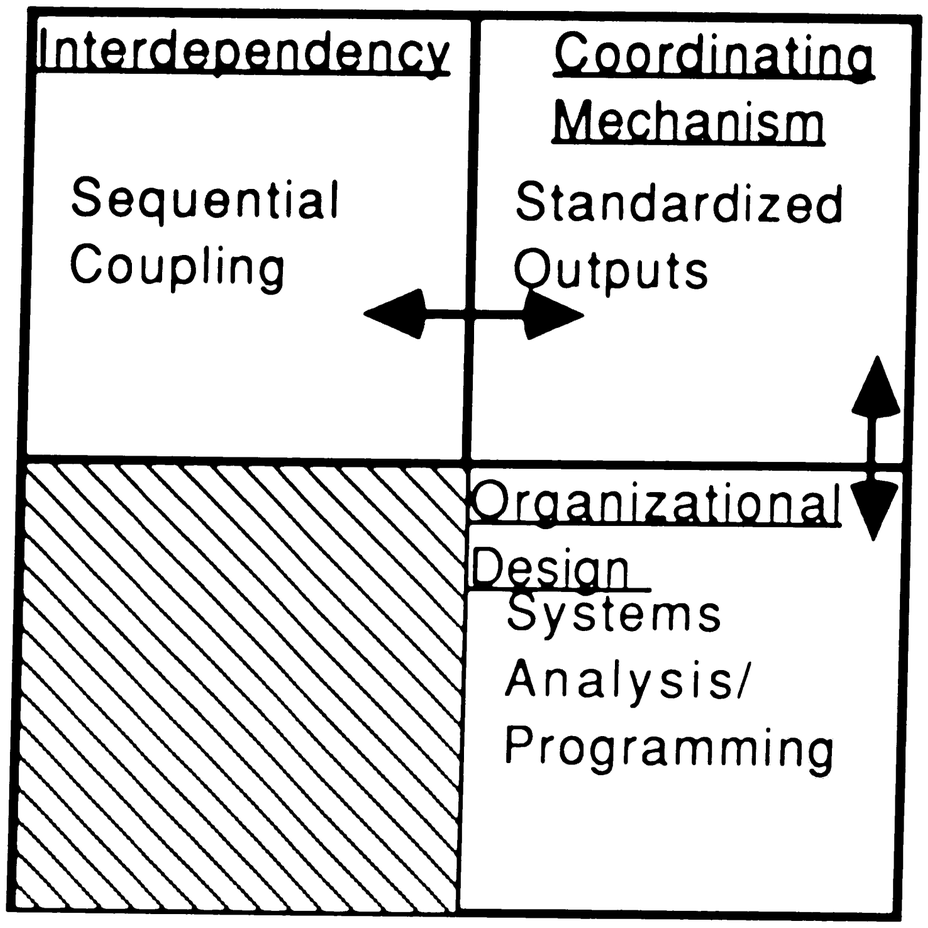


Figure 9.

This alignment shows a good fit among the organizational attributes: a sequential coupling method is pared with a coordinating mechanism that is based on standardization of outputs. In this mode of operation, a standardized work process producing standardized outputs ensures that production can move along smoothly between tasks. Also, the organizational structure, measurement, and reward systems are neatly balanced among traditional systems analysis and programming lines. This is consistent with the other attributes of the profile.

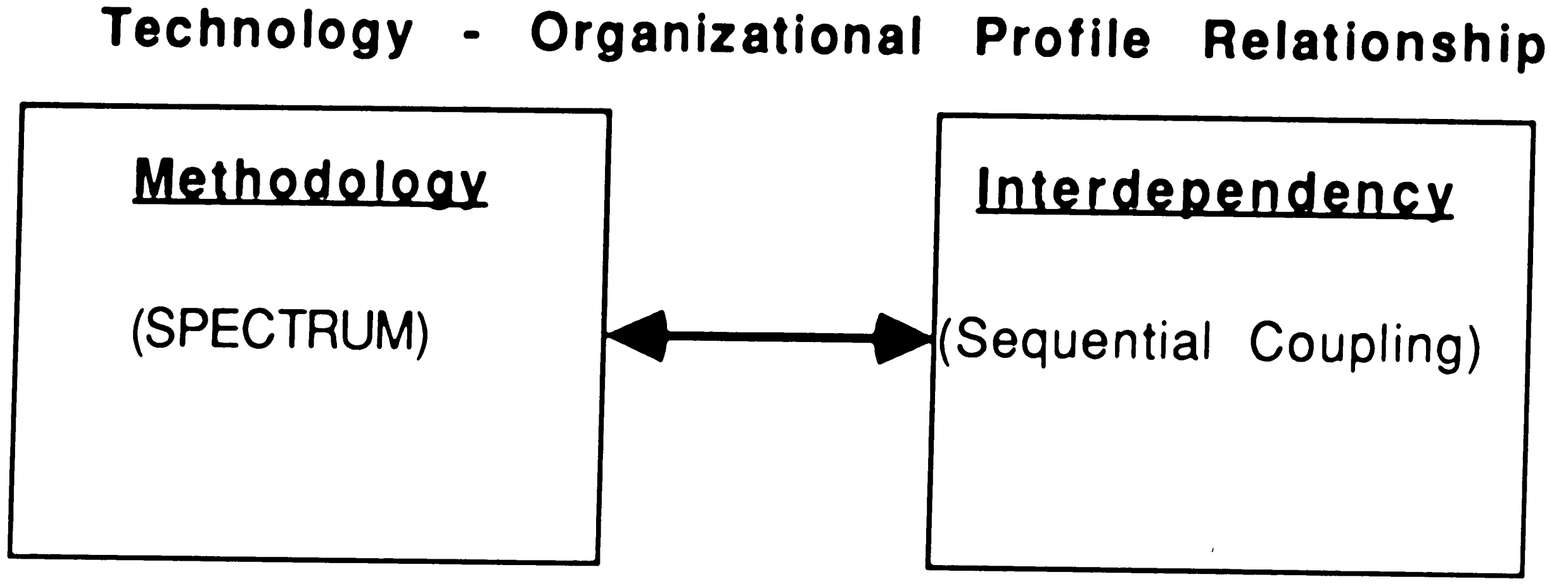


Figure 10

In looking at the alignment between the technology and organizational profiles (Figure 10), the important linkage is between the methodology and the interdependency mechanism. In this case, the SPECTRUM methodology naturally supports a sequential coupling work process, thereby promoting a balanced alignment between both profiles. In this regard, they are aligned intrinsically as well as with each other (see Figure 11).

TECHNOLOGY PROFILE
PRE-1981

Tools	Techniques	
VSAM Files	Traditional Systems Analysis	
ORGANIZATIONAL PROFILE PRE-1981		
Interdependency	**Methods**	**Concepts**
Sequential Coupling	SPECTRUM	Traditional Information Systems Development
Coordinating Mechanism	Organizational Design	
Standardized Outputs	Systems Analysis/ Programming	

Figure 11

In 1981, XYZ Company was experiencing serious problems with inconsistent information being generated by three incompatiable information systems, all of which reported the status of finished goods inventory at different times of the day from various locations. This caused a problem in both production scheduling and inventory

distribution with a negative effect on customer service. In order to rectify this, an information system that would report a consolidated daily inventory position was commissioned. The Information Services department launched a technology evaluation based on the need to obtain a database management system that would control the data from the three systems under a common software program.

In order to make a rational decision in their DBMS procurement process,, XYZ used Kepner-Tregoe Decision Analysis to weigh the relevant technical variables such as operating systems environment, security, and language interfaces. After a lengthy evaluation, the company choose a network DBMS with a front end data retreival manager (local view management system). It was hoped that in addition to managing data in a cost effective manner, the use of a view manager would enable the programming staff to increase their productivity by eliminating the need for writing file handling routines. The system was very dependent on the logical analysis of data for proper functioning and therefore, needed some methodological enhancement regarding logical database design. In order to accomplish this, XYZ retained the help of a consulting firm who convinced them to purchase a data modeling package along with a set of proprietary systems analysis techniques, which could be incorporated with the existing methodology.

After this, XYZ's technology profile existed as shown in Figure 12. It is important to note that no conceptual changes were made to the work system.

Tools-

Hardware-IBM 3081

Systems Software- MVS , CICS, VSAM Files, TIS, FACETS

Techniques-

Structured "type" Design, Normalization of data.

Methods-

SPECTRUM Information System Development Methodology.

SERVICE ANALYSIS /Database Design Methodology.

Concepts-

Process Driven Information systems development.

TECHNOLOGY PROFILE
1981

Tools	**Techniques**
TIS DBMS FACETS	Service Analysis Data Base Design
Methods	**Concepts**
SPECTRUM	Traditional Systems Development

Figure 12.

Organizationally, XYZ had the following profile (see Figure 13):

Interpendency-

Sequential coupling.

Coordinating Mechanism-

Standardized Work Process.

Organizational Design Components-

Structure-

Traditional systems development functional orientation yielding systems analysis (Business Systems Analysts) and programming (Computer Systems Analysts). A database administrator (DBA) was added to the organization as part of the Technical Services Group.

Measurement and Reward Systems-

Yearly Management by Objectives (MBO) system measuring and rewarding personnel for completing assignments on time within the parameters set by the specific projects following the SPECTRUM methodology.

The business systems analysts and computer systems analysts remained being measured and rewarded for performing their traditional functions as described by the methodology . The database administrator was being measured and rewarded on his ability to develop a physical database design that would support the requirements described by the business system analyst.

ORGANIZATIONAL PROFILE
First Attempt

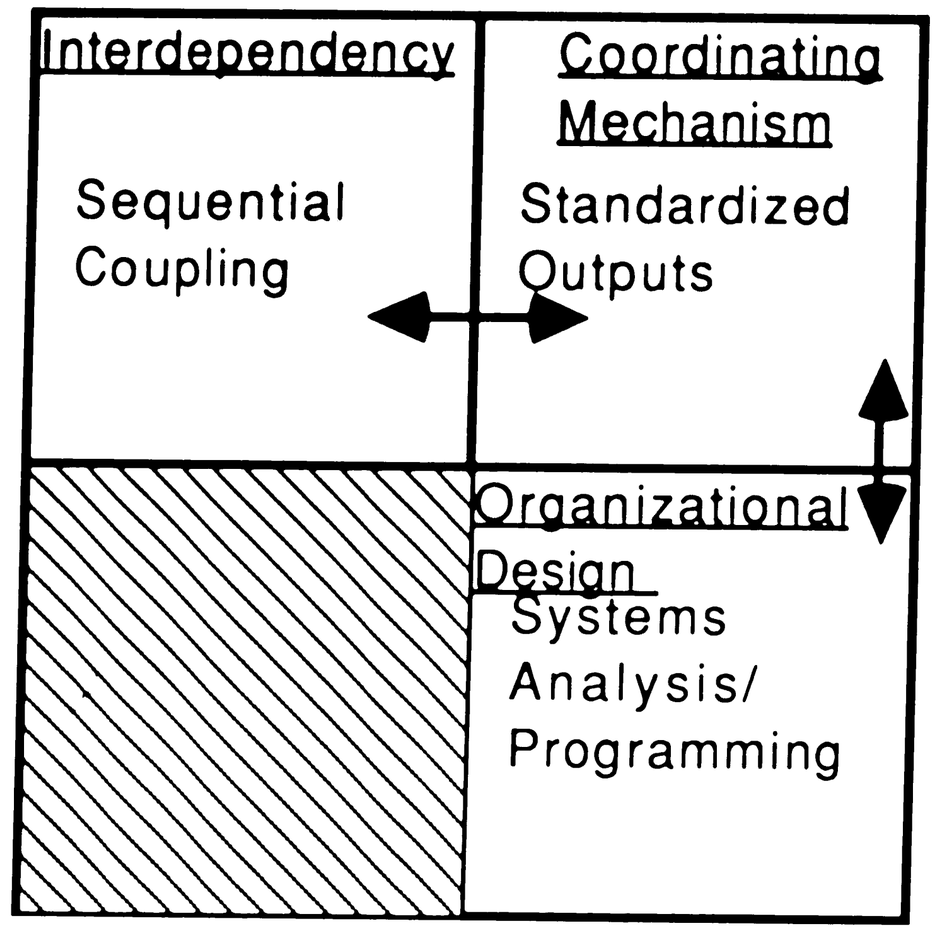


Figure 13

While a database administrator was added to the staff to perform the design and tuning of the physical database structures, no other changes were made. Indeed, the current work system and its methodology remained in the classic "waterfall approach". In this sense, the new tool (database management system) was seen simply as a file manager replacing the old VSAM structures with little value added. The changes to techniques were mostly changes in the way datat requirements regarding were documented. In this regard each taskwas termed a "service" with the data documented in the form of a "local view" necessary to perform it. The "local views" of the process were then used as the basis for the development of program specifications.

The project was led by a business systems analyst from the Business Systems Development unit. As team of users was assembled to provide information on the business functions and activities. Interview teams were organized to study the nature of each business activity (Service) that was found during the original decomposition of the business function. In addition to conducting interviews, the group went off-site for three months to prepare their documentation of the"services". Each service was documented in a design dictionary. Information regarding the data needed for the services was keyed into to the dictionary, producing a voluminous report that detailed the possibilities for a normalized database structure. This information was then passed to the database administrator as the requirement for the physical data base design.

After spending the next fourteen months in system design and development, the first test run of the system was cancelled after twenty-two hours. During that time only one third of the total processing was completed. After a review of the system and database, the project was cancelled.

Model Based Analysis

The first problem was encountered was the group's failure to recognize that database technology constitutes a conceptual change regarding the application development work system. While two new tools were added (the DBMS and the data design aid), the commensurate changes to the technology paradigm were not made.

Specifically, a database management system is premised on the inherent value of sharing data among application programs and data independence from application program control. In essence, a DBMS is a materials manager for information products. To maximize its potential value, the techniques and methodology should support this concept. While the set of techniques espoused by Service Analysis were oriented toward the understanding of data, their basic focus was on the process of data manipulation within a business activity. This process oriented approach was consistent with the main methodology, SPECTRUM and the old file handling proceedures that linked an application program directly to its data file.

With the inclusion of Service Analysis with the SPECTRUM based work system, no conflict was seen regarding the work system task interdependencies. As mentioned previously, the independent file/application approach and its associated methodology yielded a sequential process work process. Database technology, however, is more oriented toward a recipricol work flow: a design that is oriented toward one systems view of the data may have to be changed in order to accomodate another. In this fashion, the work system tasks need to recycle until all design compromises have been completed . This is in contradistinction to the traditional "waterfall" approach which cascades sequentially from step -to -step until completion.

In conjunction with the sequential approach to interpendencies, the group used a combination of both a standardized work process

and a system of outputs to control its progress toward a design document. Accordingly, the database administrator was not allowed to attend design / review sessions with the business analysts and/or users until the group had completed its tasks The results of the logical design-aid analysis, which was not graphically depicted or easily able to be deciphered, was then "dumped" on the DBA's desk as a complete design requirement. At that point, all program specifications were written and the DBA's opinion as to possible performance condiderations were neither requested nor taken into consideration: programming was already underway.

Whereas the traditional development process easily lent itself to standardized processes and outputs, the addition on the database management system added a new level of complexity that could not be accomodated with the tradional coordinating mechanism. The introduction of new technology required a return to a time of mutual adjustment among members of the work group until the new technology could be assimalated.

In looking at the organizational design components, structurally, the application development and database development units reported along different organizational lines. While this is not necessarily a problem, it became one when the applicaton developers were being measured and rewarded on their ability to meet the project schedule whereas the database administrator was judged on his ability to be a technical specialist without being tied to the success or failure of the application in question.

In summary, the failure to recognize a conceptual change led to problems in both the technology and organizational paradigms. These problems further compounded themselves through misalignments causing what was perceived as a technology failure.

In 1984, after a recess of one year, XYZ decided to reopen the issue of implementing database technology. For this second attempt, the group recognized that a conceptual change to the work system was required and implemented the technology profile described below (see Figure 14):

Tools-

Hardware-IBM 3081

Systems Software- MVS , CICS, VSAM Files, TIS

Techniques-

Entity-Relationship Diagramming, Normalization of data, Design Prototyping

Methods-

Whitemarsh Information Systems Development Methodology

Concepts-

Data Driven Information systems development.

TECHNOLOGY PROFILE
Second Attempt

Tools	**Techniques**
TIS DBMS	Logical DBD
Methods	**Concepts**
Whitemarsh	DRM Data-Driven Design

Figure 14.

Organizationally, the second attempt yielded the structure listed below (see Figure 15):

Interpendency-

Recipricol coupling

Coordinating Mechanism-

Mutual Adjustment

Organizational Design Components-

Structure-

The traditional systems development functional orientation yielding systems analysis (Business Systems Analysts) and programming (Computer Systems Analysts) was maintained. A data administration function was added that was given

control over both logical and physical database design. The Database administrator position was placed under the control of the Manager of Data Administration. The Data Administration group was under the control of the Manager of Business Systems Development and therefore reported to the same unit manager as the application developers.

Measurement and Reward Systems-

Yearly Management by Objectives (MBO) system measuring and rewarding personnel for completing assignments on time within the parameters set by the specific projects. Data administration analysts ,business systems snalysts and computer systems analysts were grouped into a project team. While team members still reported to different managers, the group was measured and rewarded based on their ability to deliver a working system to the users according on a mutually agreed to schedule.

ORGANIZATIONAL PROFILE
Second Attempt

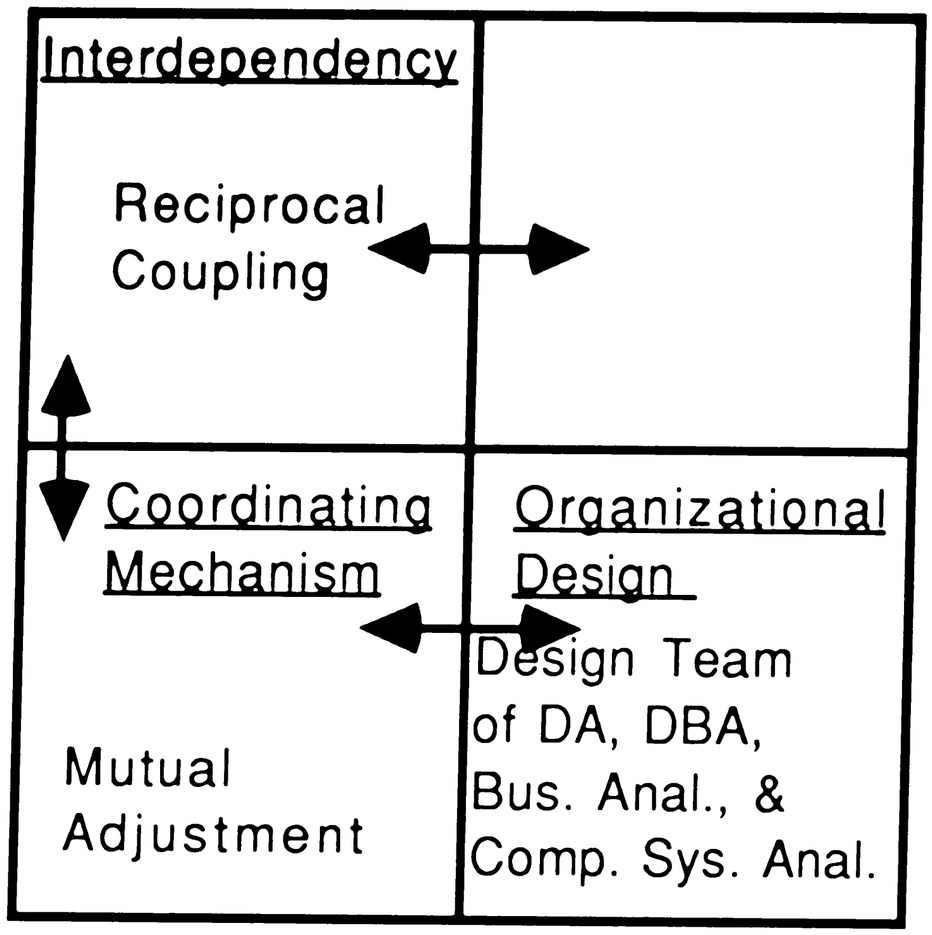


Figure 15.

Model Based Analysis-Second Attempt

With the second attempt, the biggest gain was made by recognizing that database technology fundamentally changes the way the organization does business. In this regard, the group decided that the tools would be best utilized if they were coupled with techniques that strictly focused on the design and definition of the logical data srtucture rather than on their manipulation. This would exploit the basic value of the DBMS. Since the database management system would operate as a single server queue for the application programs, the design of the data structure was crucial to the design of the

application. The requirements for processing were therefore driven by the design of the data. This was the opposite of the approach taken in the first attempt. Also, the automated design aid was not used during the second attempt. After the first effort it was observed that the developers felt thatthey did not really need to understand the essentials of good data design; all they had to do was fill out the appropriate forms, enter the data into the dictionary and a logical design would be produced. This black box approach did little to provide an understanding to the group as to how the design was produced. In the second attempt, the group reverted to manual processes for the entire design effort.

The methodology was changed from Service Analysis / SPECTRUM to the Whitemarsh Method, a data-driven prototyping methodology. The work system described by Whitemarsh enforced a iterative process that continually reviewed design specifications against technological constraints. An expanded conceptual design phase of the project required the logical data design and the system design to be evaluated against the DBMS' ability the support it. If the design was found to be unsupportable, the group was forced through another design cycle until the specifications could be met. Only after this was the project allowed to proceed to program specification and coding.

This type of work system required reciporcal coupling to accomodate task interdependency. This change forced the much needed communication among team members that was lacking in the

first attempt. Coupled with this, the coordinating mechanism for the second attempt was allowed to revert back to a period of mutual adjustment. The project was offically "managed" by the business system analyst who maintained primary responsibility for contact with the user community. Unofficially, it was decided that the data administration analyst would chair the project through the design phases that included the functional model of the business areas and the design of the logical and physical databases. After this point, the chair of the project would be rotated to the business systems analyst who would thenbe responsible for delivering the application to the user.

In looking at the organizational design components, the movement of the database administrator under the direct supervision of the newly created Manager of Data Administration coupled, with the fact that the Data Administration group now reported to the Manager of Business Systems Development, proivded a cleaner communication channel than had previously existed. Also, this fact permitted a consistent definition of how the group was to be measured and rewarded (see Figure 16).

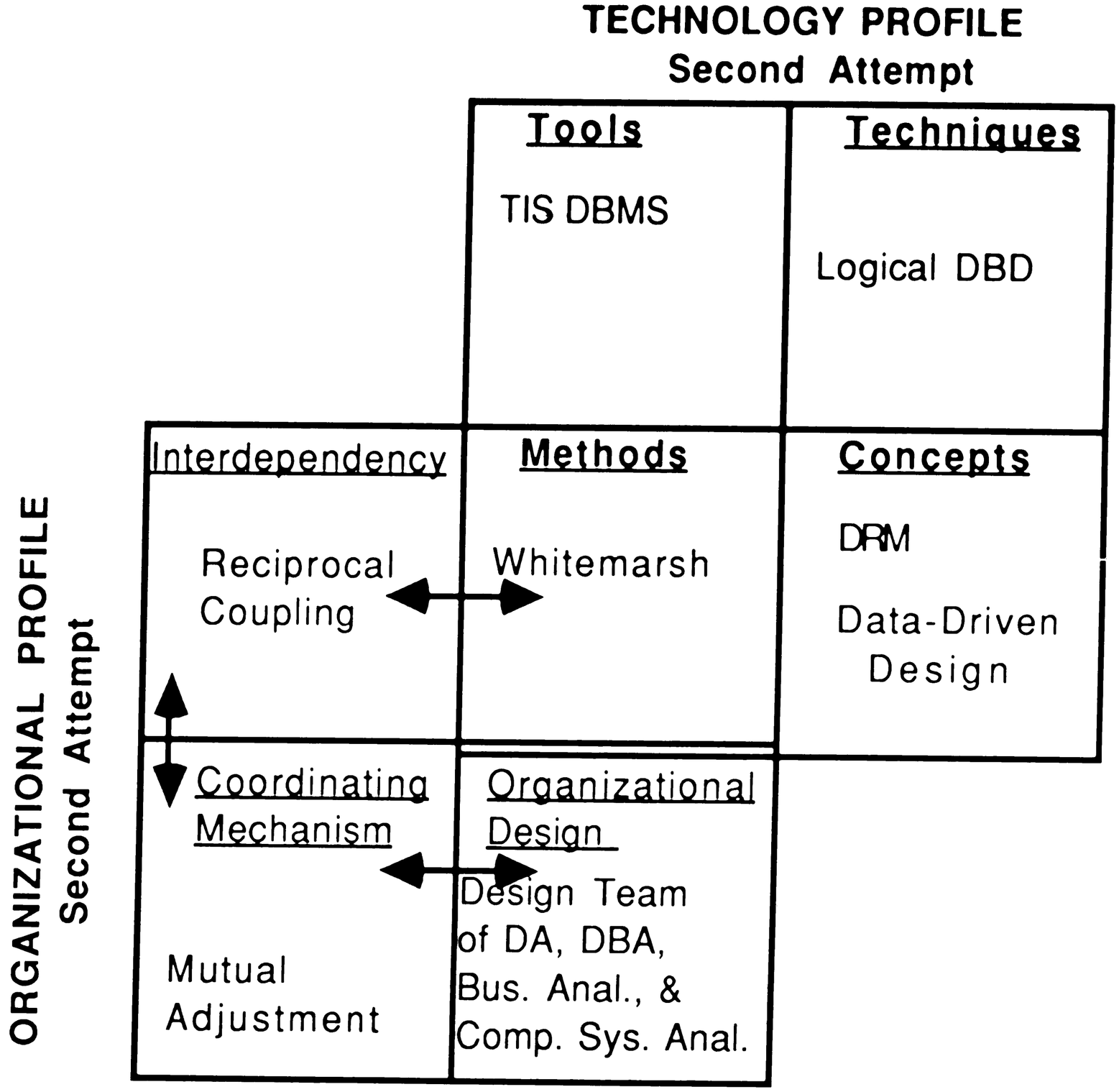


Figure 16.

With this new alignment, the group spent three months in the conceptual design phase of the project, building models of the business functions and data (both a logical data design and a physical database design). An application design was then produced and evaluated against the physical constraints for performance. After passing these tests, the project moved on to the program

specification, coding, and testing cycle.

The database was placed on-line four months after the design was completed with an on-line query facility providing immediate access to the data. Major reports were delivered to the users over the next twelve months.

CONCLUSIONS

The purpose of this research was to examine the appropriate variables concerning the implementation of technology in an information based work system. The major hypothesis stated that in an information- based work system, there are two components that need to be aligned in order for optimal productivity to be achieved: technology and organization. In this regard, it was hoped that a model of technological change could be developed that would allow managers to assess the required changes that would be necessary given their current environments. Given this type of tool, an appropriate assessment of the the ramifications of technological change could be made before implementation thereby alleviating some of the current tensions that exist in this situation. An information services area was choosen as an appropriate test environment since the work system was purely information-based.

The major conclusion from this effort is that technological implementations that fail to recognize the implicit organizational implications are doomed to disaster by the very structure of the work system / methodology they are intended to support. This was evident by the mis-alignment of the "waterfall" development approach when contrasted with the functional capabilities of the new tools which required a different work system in order to operate effectively.

A second major conclusion is that each tool implies an

appropriate technological and organizational paradigm necessary for an effective implementation. This was shown in the example of database management systems which require the techniques and methods of data sharing in order to fulfill their role as overall data managers for multiple applications. This change in concept, led to the associated requirement for the changes in the organizational paradigm. While this was driven strategically by the organizations desire for more effective data management, it was in fact undertaken due to the desire to achieve the benefits of a technology investment that had not been realized. In this regard, it is hard to imagine that this was truly anything but the realization of a "technology-driven vision". For a true business vision to be realized, a coupling of this paradigm with an emphasis on business strategy by SBU or Line of Busines would have been necessary.

In conjunction with the above is the surprising finding that the information technology managers of XYZ were not aware of what their work system truly encompassed or what the appropriate linkages in the current work system were. This fact, while not exclusive to XYZ, makes it hard for a manager to explain current performance with any level of confidence, let alone explain variances after a technological change. Therefore, this research suggests that the most useful course of action for an information technology manager to take would be to determine his /her current technological and organizational profile and review the linkages and misalignments that currently exist. After this, with an appropriate model of the

environment, future changes can be measured as to their possible effect.

RECOMMENDATIONS FOR FURTHER STUDY

The work that was done in the preparation of this thesis was the first step in the development of a methodolgy for introducing technological change. However, more research needs to be performed in order to determine its general applicability. As a result of this research, there are two recommendations for further study.

1. The approach that was described in this thesis should be tested in other information-based work system environments. Through this process, its applicability beyond information services, and its potential as a general model of technological change, could be evaluated.

2. Future efforts in this area should attempt to define a corresponding measurement system that could be applied to the model. This would enable managers to determine the trade-offs among the various components of the technological and organizational paradigms in a rational manner.

FOOTNOTES

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