THE ORGANIZATIONAL AND INFORMATIONAL CONTEXT OF LARGE BUSINESS SYSTEM INTEGRATION PROJECTS

An examination of the problems encountered when designing large integrated business information systems from the perspective of the organizations' environmental and informational requirements.

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ABSTRACT

Many computer systems today have evolved into hybrids of assorted subsystems. This assortment can include systems of disparate technologies(batch, data base ...), hardware configurations and of different chronological ages.

As managers try to 'forge' these hybrids into homogeneous, integrated systems, they are discovering that integration means more then simply the physical compatability of its component parts.

Standardized protocols, gateway machines, and translation strategies can help, but after all of these 'physical' incompatabilities are resolved, a much larger problem, the problem of informational and organizational integration becomes apparent.

When the practioner of large BUSINESS systems design attempts to apply readily available theory to these issues, he finds that his challenge is not only to 'solve' data management problems, but to 'uncover' what the real problems are when applied against the backdrop of business organizations and their often contradictory informational needs.

The author proposes that this problem definition process can be greatly facilitated by a better understanding of the business's organizational environment and its relationship to the computer environment.

By examining the organization itself as an information gathering/distributing system, the individuals' needs for information are described in terms of information requirements. Computer system organization, data storage and access methods are then evaluated in terms of their ability to meet those informational needs efficiently.

Finally, an approach to large system integration based upon these informational requirements is proposed.

I. INTRODUCTION

For those people involved in the design and development of large business computer systems today, it seems to be getting increasingly difficult to produce systems which provide meaningful information in a cost effective way. This difficulty can be attributed to many factors:

Nolan (28) cites the stages computer systems will go through, and the inherent inefficiencies as the systems mature.

It is also apparent that, as the system users become more sophisticated, their demands for more and better information will continue.(4,15)

New technologies also contribute, by imposing more layers of complication upon environments already technically robust.(5,21)

These factors notwithstanding, the ever increasing demand by management to 'blend' previously independent or loosely coupled computer subsystems into integrated information systems will pose one of the toughest challenges to practioners for some time to come.

Although technically difficult, theorists have been addressing these issues for some time, and an impressive body of knowledge is available to aid the practioner in the development of useful approaches, both from the generalized systems design point of view (2,17,29) and specifically in the area of distributed systems design.(13,16,18,23,24,25,26)

Unfortunately, when it comes time to apply these approaches, the systems designer invariably becomes embroiled in controversies only remotely related to the 'traditional' systems analysis and design functions.

These controversies center upon the problems created for the organization itself, when previously independent information systems are required to 'pool' their resources, and create a homogeneous view of the information they contain.

One aspect of this problem involves the identity and integrity of the data itself, that is, those issues associated with data management. (3,8,20)

Another aspect involves the social and psychological issues uncovered when changing systems which are an intregal part of an individual's work identity. (9,10,14,19,31)

Although these approaches and methodologies can support the design process, without a good understanding of the organizational context within which decisions must be made, the application of theoretical approaches can serve to make the process harder, instead of easier.

By examining the business's organizational environment, and understanding how it relates to it's computer environment, some useful insights are possible.

We investigate this relationship from the organizational, informational, semantical, and political perspectives, and based upon this examination, present a model for explaining how the systems integration process might be approached to capitalize on the insights provided by this perspective.

II. ORGANIZATIONS, THEIR STRUCTURE, EVOLUTION, AND COMPUTER SYSTEMS.

In the classical view the business entity is hierarchical in nature,(9) and whatever structure the business takes, this 'chain of command' will shape the way individuals communicate, both formally and informally.(12) Well defined chains of command are created, where each individual reports to only one indidual higher in the 'pyramid'. When viewed in this fashion, the business hierarchy looks comprehensive. (diagram A)

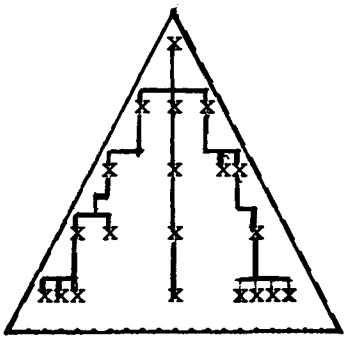


DIAGRAM A

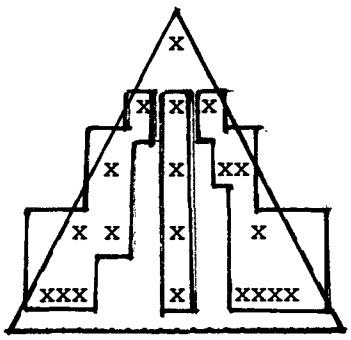


DIAGRAM B

These individuals are placed together in order to form independent working units (departments/divisions); and these units are commissioned to operate as efficiently as possible within their own, well defined scope. In this sense, the 'pyramid' might better be viewed as stacks of building blocks. (diagram B) When seen this way, it becomes apparent that the corporate structure is not as thorough as originally envisioned. In fact, there are many gaps between departments. These gaps expose two problems: a) the fact that there are interdepartmental communication needs that no one is responsible for and therefore b) that there are many things occuring within the business which are not controlled by these well defined chains of command.

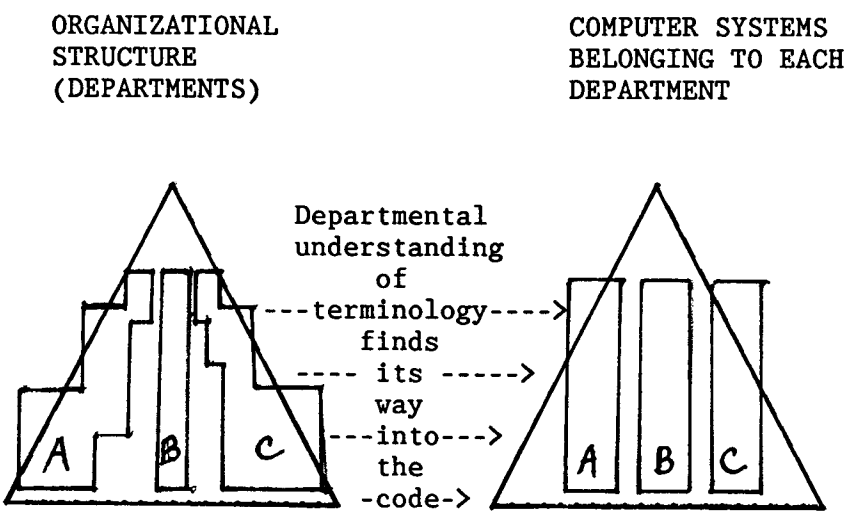
Once organized, each one of these stacks of blocks (departments) proceeds to become as efficient as possible. Unfortunately, the process of becoming efficient causes two negative side effects.

1. Efficiency within the department is facilitated by the development of a jargon or special language (a mutually agreed upon understanding of what certain acronyms, phrases, and key words mean). Over time, each department will develop its own and separate jargon, often assigning slightly different meanings to commonly used words.

For example, Accounting, Marketing, Production Control, and Purchasing associate a different meaning with the terms 'Net', 'Gross', 'Order', and 'Revenue'. Any interchange between members of these groups becomes muddled since the slight variations in meaning tend to compound themselves over time.

2. An important part of each departmental unit's efficiency can be traced to its computer systems. These systems, although centralized in theory, usually organize themselves in alignment with the departments they serve. One group of programmers works on all production department code, while a different group works on all marketing code. (see diagram C) In this case, not only does each department have its own language, the departmental jargon is coded right into the computer. Programs do not distinguish between subtleties of meaning intended, and once the information is stored according to one code of understanding, it is difficult to alter.

DIAGRAM C .



As long as business conditions are stable, management will see no reason to 'fill the gaps' between departments, and departments will have no reason to communicate in new ways. However, when changes occcur, management will try to fill these information/communication gaps. Although 'meetings', liason officers, and control documents can be used to 'bridge' these communications gaps, eventually, if the need for information becomes too great, the business will create another department in order to collect the information needed. Quality Control, Customer Service, and Product Development are examples of these 'bridge' departments. Their purpose is to cross traditional departmental lines in order to effectively coordinate activities between groups.

Although this solution meets the short term goals of management, in the long run, problems are simply compounded. Since the newly created department has its own mission and efficiency considerations, it will develop ITS OWN JARGON AND ITS OWN COMPUTER SYSTEM.

So, departments are added and dropped, and the scope of surviving departments is broadened or constricted in response to these organizational changes. It is against this backdrop of organizational flux that business computer systems exist.

Because the meaning of the information within the departmentally based system is dependent upon programmers' and analysts' interpretations of the departments' current scope, when the departments scope changes, the computer system should change too. All too often, however, these changes would yield subtle and therefore economically unfeasible results, so the slight information pollution is left alone.

How is it possible that the improperly identified information can be allowed to exist and even be usable to the people working within the organization? Since the people using the systems are a part of this change process, they adjust their interpretations of the information they see to reflect the new meanings(they redefine their jargon).

This solution is in and of itself not unreasonable. As long as only those people within the department need this information, no harm is done. For that information critical to interdepartmental communication, Accounting kept the corporation in sync by tracking transactions. But, in today's world, much of the information important to business operations defy accounting disciplines; i.e. there is no room on a balance sheet for MARKET SHARE, METALLIC FAULT, or TOLERANCE LEVEL. This non-accounting type data, and the proliferation of vast computer systems that track it, contribute greatly to corporate communication problems today. Although the technology has been advancing quickly, the human ability to change organizations and information needs is still much faster.

III. VIEWING THE BUSINESS AS AN INFORMATION SYSTEM

From this perspective, businesses can be seen as collecting information about the external environment (marketing data, raw material prices, customer orders, etc.), using that information to make decisions about how best to allocate its internal resources, and then sending messages back to the external environment about its ability to meet consumer needs (filling orders, sending salesmen, advertising). Employees can be viewed as not only belonging to a traditional command hierarchy which supports the manufacturing of goods and services, but to a communication hierarchy as well, which supports this flow of information.

It is proposed that businesses with good communication, that is, those which elicit the right information from the external environment and respond quickly to it, have an edge over companies that do not. Management theorist, Peter Druecker(6,7), discusses the importance of information and communication within the organization, and even proposed the concept of a 'knowledge worker', an employee who generates no physical products, but who facilitates production through the effective use of expert knowledge.

On the negative side, studies (1,27) document cases where one of the major contributing factors to a company's failure was its inability to respond quickly to the environment. Organizations with poor communication are often the first to fail in times of economic downturn.

Conversely, communication can help explain why small 'upstart' companies are the first to capture new markets. Since these smaller companies have better and faster communication, they are better able to read the environment and can respond long before the large corporations even seriously consider there to be a consumer need. (A good example of this in the micro computer industry is the initial success of the Apple Computer Company).

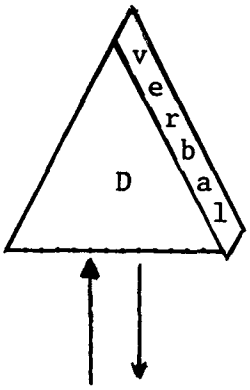
The validity of this concept, and more importantly the computer's contribution to the efficiency of business operations is the subject of much study of its own.(27,30)

Regardless of the specific contribution to productivity computer generated information makes, since the business is so dependent upon information for its very survival, and since computer systems exist to augment that communication process, an understanding of informational flow within the organization should contribute to the ability of the computer systems designer to make decisions that meet the business's needs.

IV. CHANNELS OF COMMUNICATION.

When small, a business has only one channel of communication: verbal.
This channel is fast and versatile, but not very dependable.
(see diagram D)

DIAGRAM D

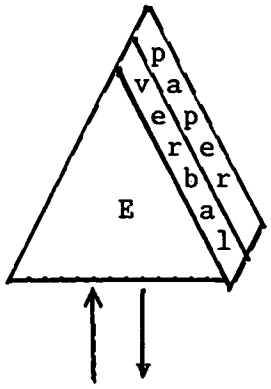


EXTERNAL ENVIRONMENT

(customers, competitors, suppliers, government etc.)

As the company grows, verbal communication falls short because every employee cannot possibly consult all others each time a decision must be made. The paper channel is created. It accomplishes wider information distribution; but is restrictive, since less can be communicated.
(see diagram E)

DIAGRAM E

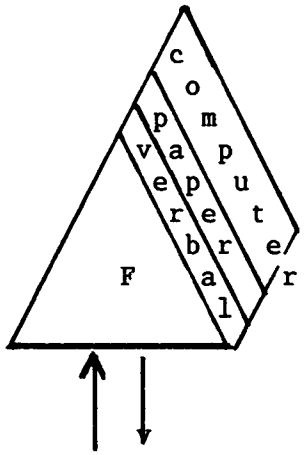


EXTERNAL ENVIRONMENT

(customers, competitors, suppliers, government etc.)

While further enlarging, the business finds itself drowning in paper, and a computer communication channel will be added. In fact, once the company takes on real magnitude, the computer channel takes over as the principle means of communication. In some very large corporations most activity stops when the computer "goes down", since no other communication is possible.
(see diagram F)

DIAGRAM F



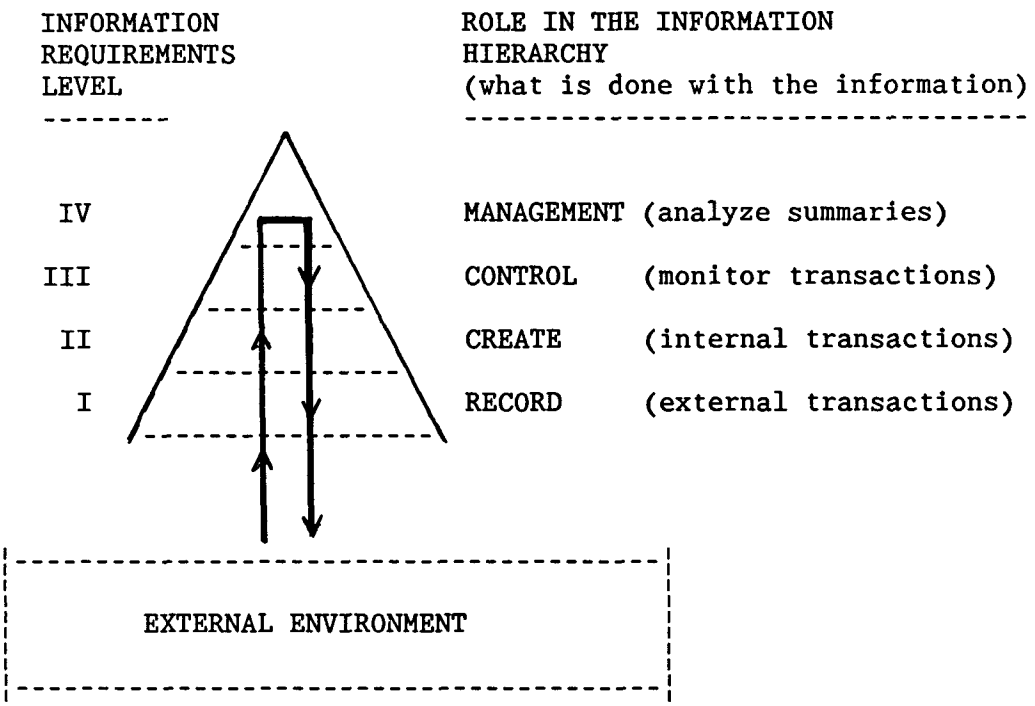
EXTERNAL ENVIRONMENT

(customers, competitors, suppliers, government etc.)

V. THE COMMUNICATION HIERARCHY - WHO COMMUNICATES WITH WHO(M)?

The information hierarchy is almost identical to the corporate organizational hierarchy itself, except that the roles within it are defined differently. These roles can be subdivided into 4 major groupings. (see diagram G)

DIAGRAM G



I.EXTERNAL TRANSACTION PROCESSING (MARKETING, SALES, SHIPPING, RECEIVING, AND PURCHASING)
(sales clerks, purchasing agents, receiving and shipping dock personnel, bank tellers, etc)

At this level employees are concerned with collecting information about the external environment, recording it, and communicating the corporation's response back to the external source.(For instance, they take customer orders and later notify the client that the product is ready.)

II. INTERNAL TRANSACTION PROCESSING (PRODUCTION "LINE" PERSONNEL)
(expediters, shop-floor personnel, accounting clerks, etc.)

At this level responsibilities include reacting to the information collected at level I, communicating the need for required resources to other employees, reporting progress and status to management, and advising the level I employees when the consumer needs will be met. (For example; they fill and ship orders.)

III. CONTROL OF TRANSACTION PROCESSING (MIDDLE MANAGEMENT) (supervisors, foremen, accountants, department chiefs, etc)

At this level the concern is monitoring the activities on levels I and II, assuring that the individual departmental units are performing efficiently, and keeping upper management informed as to problems with the way things are done.

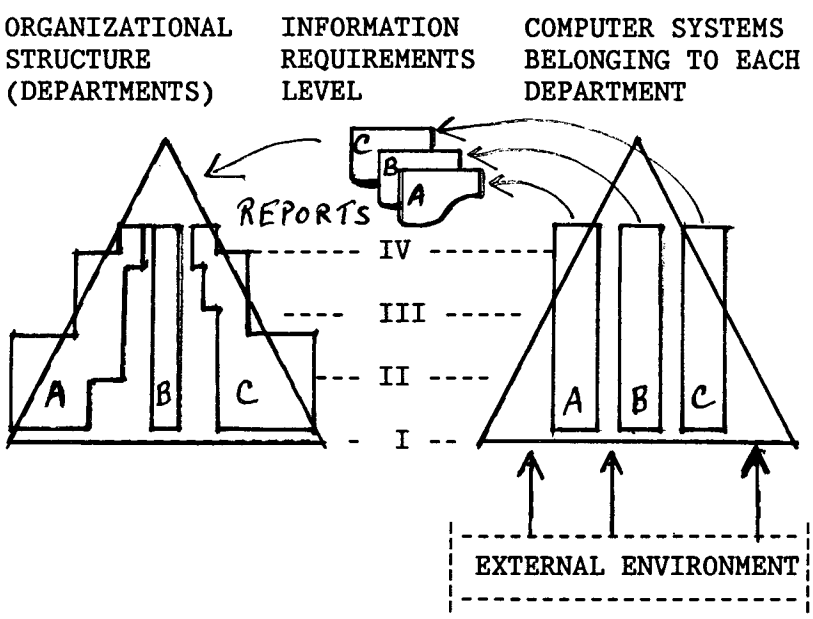
IV. DIRECTING OF THE OVERALL BUSINESS (UPPER MANAGEMENT) (executives, auditors, etc.)

At this level the focus is on the overall performance of the business, coordination between individual departmental units, and guaranteeing that the business will be able to keep meeting consumer needs.

By looking at these information requirements, insight into the communication breakdown becomes possible. Although the information needs at each level of the corporation are very different, existing communication channels usually follow the traditional departmental structure from the bottom to the top. If the computer systems, the main communication channels for large corporations, are departmentally based, each departmental system will attempt to summarize and condense its information for the use of level III and IV personnel; but what it presents will be limited to the scope of the department creating the data. Obvious in these reports to management will be departmental jargon, words and phrases with a meaning specific to the department, and meaningless or having a different meaning to people in other departments. This jargon, however, is a symptom. The disease is a myopic view of the corporate world imposed upon the departmental reports by their limited input. (see diagram H)

A manager trying to make corporate decisions using departmentally supplied reports is like a mathematician trying to figure out how many apples and oranges it takes to make a pear. It simply does not compute.

DIAGRAM H .

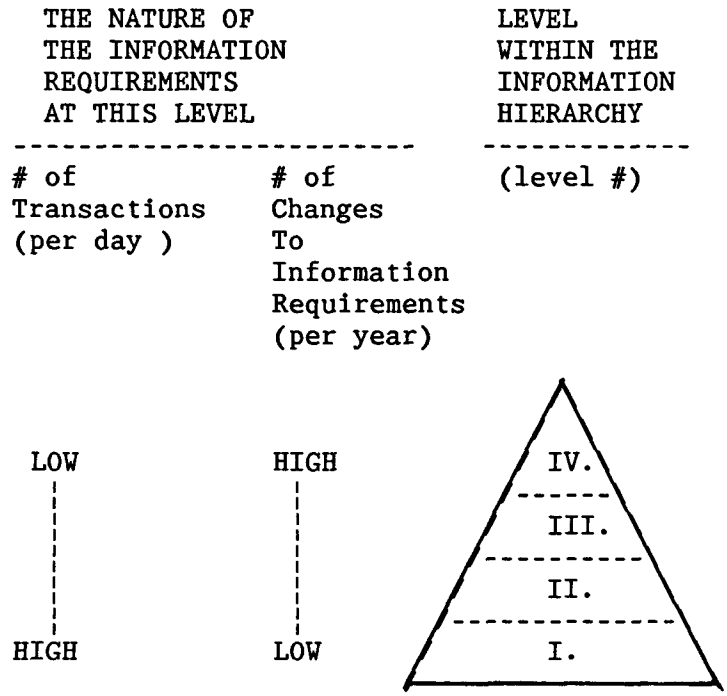


The solution to the problems of mis-interpreted information within the corporation, and to the optimization of systems design might best be approached by viewing the computer systems for what they really are: systems used by the corporation to collect and disseminate information. This communication, however, takes different forms at each level, and each level requires the computer system to do different things. These functions parallel the nature of the work and the sophistication of the individuals involved in performing the tasks.

VI. BASING SYSTEMS REQUIREMENTS ON THE INFORMATION REQUIREMENTS LEVEL

At level I there are many employees requiring a highly structured work environment, and generating a high volume of transactions. Therefore, the systems and architectures to support those systems should be designed to optimize for these aspects. They should be highly structured, easy to monitor, difficult to tamper with, and perform a high volume of transactions at a low cost. At level IV there are very few individuals generating a low volume of transactions, but needing various kinds of information at different times. In fact, a continuum of these two aspects of information requirements exists as you go from the top to the bottom of the hierarchy. At the lowest level, there is a high transaction rate, but a low need to reconfigure that data (the informational requirements are stable) and vice versa. (see diagram I)

DIAGRAM I .



Whereas, historically, it made more sense to build subsystems at a departmental or functional level and to allow them to perform as complete mini-systems in and of themselves, the current tendency toward integration and consolidation would indicate that it is time to consider subsystems based, not upon how to get them to serve all levels of the information hierarchy, but upon their ability to meet the needs of particular level as efficiently as possible.

If approached from this perspective, not only will the system perform more efficiently, but the individual subsystem will be insulated from the dynamic departmental reorganization cycle and its inherent redefinition of the computer systems' scope. This dynamic restructuring of scope can be isolated at the upper levels of the information hierarchy where the system can be built to optimize on this requirement.

By capitalizing upon the different computer architectures, and using the one best suited to meet a certain level's information requirements, both informational and operational efficiency be served .(see diagram J)

DIAGRAM J .

PROPOSED APPROPRIATE COMPUTER ARCHITECTURE /DBMS (level #)	RELATIVE COST OF USING THIS ARCHITECTURE	
	Cost Per Transaction	Cost Per Change To Information Requirements
relational	HIGH	LOW
network		
hierarchical		
batch processing	LOW	HIGH

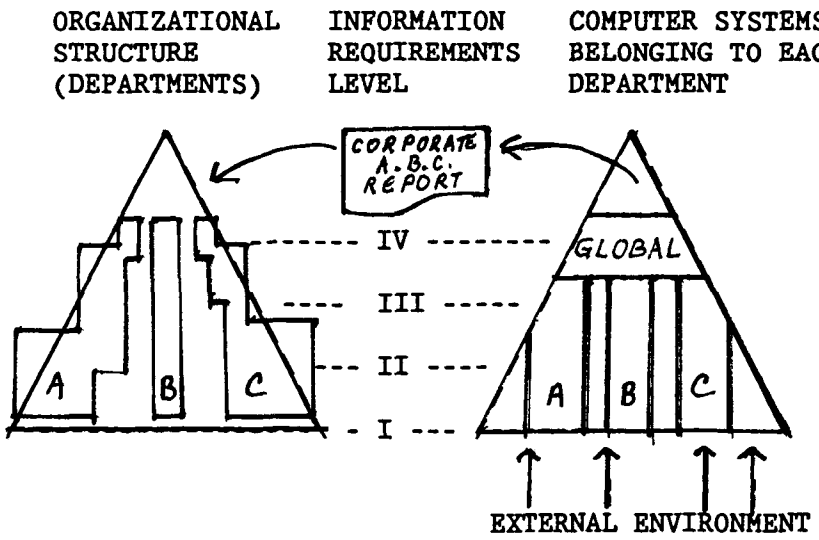
The people at top levels of management are the only ones requiring a truly global view of what is going on, while the employees at the lower end of the pyramid operate most effectively working with a limited vocabulary and limited view of the corporation.

This approach is not submitted as a formula, or answer to all the problems the systems designer faces. The problems encountered are much more complex then covered by this generalized view. However, the approach can be helpful in the decision making process because it offers the designer another perspective from which to make decisions.

In fact, a recent large integration project, involving the consolidation of information from dozens of independent transaction processing systems into one corporate information system was designed along the lines just suggested.

The objective was, to keep the existing, departmentally efficient computer systems in place at levels I and II where control, high volume, and efficiency are the key, but replace the management reporting portions with one GLOBAL INFORMATION SYSTEM. The approach then, to CONSOLIDATE AND GLOBALIZE THE COMPUTER SYSTEM ONLY WHERE IT IS NEEDED. (see diagram K) This consolidation and globalization of information gives management a truly "overall" view of what is going on out there, a view unprejudiced by departmental bias, and insulates existing systems from the informational reorganization.

DIAGRAM K .



This approach is not revolutionary; indeed, examination of successful large corporate computer systems often show the use of different architectures for varying application areas.

The global information system concept has been proposed before. What is unique about this approach is that it does not attempt to engulf the entire corporation in one mega computer system, a proposal which would be technically and economically impossible for many years. This approach simply isolates a small percentage of the corporation, namely management, and recognizes that their information requirements are the only ones that need gloabaly identifiable information (A shipping clerk cares little about net revenue versus net sales) The creation of a global information system is then not so unreasonable.

If this concept seems simple and do-able WHY THEN IS IT NOT USED EVERYWHERE ? There are 3 reasons.

1. POLITICALLY - Within the corporation each department has its own system, and this system provides reports to management. Who then is in control of the information management gets about how a department is performing? Why, the department itself. A global information system would take that power away from the individual departments.

2. SEMANTICALLY AND LOGICALLY - Each department, its personnel, its interfaces with other departments, its computer support personnel, and its programs are full of departmental jargon. This jargon is not easily reconciled into a global corporate language. If the jargon was easy to translate there wouldn't be a problem. If erroneous uses of terms are discovered, the rewriting of computer code can get very costly. At a minimum, the corporation must first determine exactly what the global language is, and then figure out how to translate each department into that language.

3. TECHNICALLY - Until recently, there was no computer system available which could do the centralized reporting function in an efficient, versatile and easily changeable way. Management requirements for information change so often, no system available could respond to those changes quickly and economically. Until now, corporations were better off with departmental reporting, since any attempt to build reporting facilities with third generation computer technology would have been too expensive and inflexible to offer a long term solution.

This global information system can only be effective if:

1. The data within it is logically well defined.
2. The information within it is understood by all users of the system to mean the same thing.
3. Politically, the owners of the current computer information are willing to give it up and turn it over to some, hopefully, neutral third party (namely, the corporate data warehouse).
4. Technically, the corporation has the software, hardware, and computer personnel necessary to support an implementation.
5. Analytically, the corporation has skilled business and systems analysts that can translate existing jargon and computer systems into a meaningful global structure.

In other words, the benefits of a global system are offset by the cost of unraveling the semantic mess many corporations find themselves in. If, however, the benefits do outweigh the cost, one attack plan that minimizes the risk of 'trying' it would be to pick a new reporting function, one unmuddied by political and semantic problems, and install this system.

If this prototype is built well, it should

a. be less costly to install and maintain than any previously installed computer reporting system,

b. offer more flexibility in reporting than previously experienced

c. have created a nucleus of expertise that the corporation can then call upon to attack the real global information system issue.

Finally, for the installation of a global information system, three points are important to note:

1. The political, logical, and semantic problems precipitated by attempting the implementation, if left unresolved, will continue to erode the corporation's ability to react to the external environment efficiently. The companies with better and faster communication channels will win, the poor communicators will loose.

2. The installation of the system can help in the resolution of these problems and can be an agent in their resolution. Once the global information system is installed, no one department can corrupt the integrity of the information without causing all other departments to protest.

3. Semantically 'clean' stored computer data is the kind of information the next generation of artificial intelligence and expert systems will require in order to do even more efficient processing of information.

VII. CONCLUSION

The existing corporate world is experiencing problems with the way information is handled. Many words have different meanings to different people, and there is no mechanism in place for reconciliation when communication breaks down.

This information gap causes inefficiencies in the ability of the corporation to compete. Businesses with better internal and external communication get more business.

By looking at the corporation as a large information processing unit, it is noted that the very departmental / hierarchical structure that gives the corporation it's efficiency, causes it to have problems with communication. The bigger a corporation gets, the harder it is to keep the channels of communicaation flowing.

It is also noted, that since computer systems are one of the main communication tools of the corporation, and since management's needs for information change faster then the departmentally based management information system can support since this would hamper the departmentally based systems ability to perform it's principle functions efficiently, that the systems designer should consider the separation of sub-system functions along the lines of informational requirements as opposed to hierarchical ones.

This approach offers a simple, straightforward and logical way for management to attack the problem of unmanageable computer systems, and more importantly, for all people involved in the corporate business world, to return to the 'shared common view ' of reality that made large corporations so successful in the past, and can make them even more successful in the future.

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