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On seeing information systems as bridges

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On Seeing Information Systems as Bridges

Introduction

The drive in today's business world is to develop and apply ever faster computers and ever more sophisticated information systems. Such a view is stated in no uncertain terms by Burrows (1986) who maintains that companies must automate in order to survive. Computerized information systems are seen as the saviour to many problems. A local producer of leather products has recently invested half a million New Zealand dollars in a Manufacturing Resource Planning (MRP II) package in the belief that the numerous production problems will be solved by the master production schedule generated by the system. The very real danger this company faces is failure to give full and due consideration to the way it presently organizes it's business activities in human resource and organizational form terms.

Despite the continuing heavy investment in information technology by firms in all business sectors, conflicting results for the impact of IT on organizational performance have been reported (Weill and Olson, 1989 and Weill, 1992). Cragg and King (1992) studied the level of information system sophistication and financial performance of one hundred and twenty (120) computerized small engineering firms in the West Midlands (UK). They found that, " . . . for these firms with computers, lower IS sophistication is associated with higher financial performance." (p.424). Despite the limitations noted by Cragg and King, their study sounds a useful warning bell.

This paper takes as its basic belief that implementing a computerized information system involves more than merely putting a computer into the organization. It contends that an information system consists of three major elements: *people*, *technology* and *organizational form*. To this end a metaphor is proposed to help understand the relationship and interaction between these three elements. It should be noted that whilst the paper is written from a manufacturing perspective, the proposed metaphor can be applied to other areas of the information systems field.

The Role of People

The Mass Organisation study "People in Production" (1942) found that those female war workers in a huge aircraft factory who had little idea of how their jobs contributed to the whole, or of the level of their jobs' importance, were more likely to be dissatisfied with their role and believe that they were not helping to win the war at all. Similar findings were reported by Bailey (1983). This suggests that one important factor for people to maximise their performance is a knowledge or a broad understanding of how they contribute to the overall organization.

This need to know how one fits into the greater scheme of things is an old one that has been pursued by philosophers over many years. For example, Emmet (1968) writes, "Most human beings are curious . . . in the sense that they want to find out about the world around them and about their own part in this world.

The Role of IT

The traditional role of information technology has been to improve the productivity and efficiency of a company. In the beginning firms automated their large transaction processing systems, such as inventory and purchasing. More recently there has been a shift towards systems that enhance or automate tasks previously undertaken by human staff. Designers can now use CAD systems to design objects in three dimensions. These systems can animate the designs created, thereby removing the need to build physical prototypes. Unskilled and semi-skilled labour has been replaced by computer-controlled machines and Flexible Manufacturing Systems which aim to make higher quality products at a faster rate than their human counterparts. From the early eighties the concept of Computer Integrated Manufacturing (CIM) gained prominence with the emphasis on a factory that was built around a computer system linking all aspects of manufacture together.

The Organizational Form

Many organizations have developed under the influence of Taylor's theory of the Specialization of Labour. For example, a factory is organized along functional lines so that each department will be responsible for a number of related tasks. In this way the various elements of the process are separated. Within each function related tasks are further broken down into small, discrete elements. On the production line, for example, each element will be simple to perform enabling newcomers to be trained quickly and efficiently.

This "traditional" organization is often represented as a pyramid. At its apex is a small number of individuals whose job is akin to the Captain of a military navy vessel: providing the instructions to steer a course through the treacherous waters of the competitive world. As one moves down through the ship's company (the organizational pyramid) one meets the junior officers and non-commissioned officers who implement and execute the Captain's orders. At the base of the pyramid are the ratings who perform the myriad of tasks that are required to achieve the result desired by the Captain. The ship, like the factory, has its various functional units, each with a particular task. Range finders (Marketing) determine the location and range of the target; the armoury (Production) provide the ammunition to fire and the gun crews (Distribution) arrange delivery. All units must work in a co-ordinated fashion to maximize the chances of success.

Hayes and Jaikumar (1988) state that in times of stable consumer demand and predictable competition such a structure was ideal. They argue, as do Bolwijn and Kumpe (1990), that in today's reality such a structure is no longer suitable and companies must seek other ways to organize. The approaches taken are many and varied. These include Networked Organizations (Snow et al. 1992), Learning Organizations (Senge, 1993), the flattening of management layers and the breaking down of a large organization into Separate Business Units.

Each company has its own culture and style dependent upon a host of factors including management, the business area and various individuals. Whilst these are closely allied to the structure of the company they are sufficiently distinct to be considered separately (Bailey, 1983 and Handy, 1985). For this reason Lambert and Peppard's (1993) concept of

organizational form is useful in this context. It treats organizational form as a combination of structure, systems, management styles, cultures, roles, responsibilities and skills. This definition goes beyond merely considering if an organization is arranged in a hierarchical manner and allows scope for other variables to be considered, something that is both desirable and necessary.

Problems with automation

Shapiro et al. (1992) believe that most manufacturing companies are organized along vertical function lines. In their article 'Staple Yourself to an Order' they break the Order Management Cycle (OMC) down into ten steps (Appendix 1). They argue that, in the traditional organization, each of the steps is divided into functional roles that create gaps or cracks between the various stages of the OMC. Such a view is echoed by Hayes and Jaikumar (1988) who believe that many of the problems modern manufacturers face are due to the organizational structure which, " . . . divides key people into separate functional responsibilities and measures their performance using different yardsticks." (p.79). These cracks are detrimental to the progress of information across the OMC because the information can fall between them. Shapiro et al. state that when information is lost between the functional responsibilities production time is wasted as efforts are made to find out where the information is, how accurate it now is and how its loss could be avoided in future. Bloodgood and Thacker (1989) and Ayers (1990) appear to be in general agreement with this view.

Miller (1988), Unterweger (1988), Zailyk (1989), Costea (1990), Shapiro et al. (1992) and Beatty (1992) feel that information loss can be alleviated if the company aims to fit the pieces together in an integrated whole. The consensus of these authors is that the company will only achieve this integration if it adopts a *process orientation* as opposed to one which is centred around a series of separate tasks. By doing so these authors believe those artificial barriers introduced by functionalization will be broken down. However, there are two major obstacles to overcome before this can be achieved. The first is technical and the second pertains to the organizational design of the institution.

Technological Issues

Much of the Computer Integrated Manufacturing literature talks about "islands of automation" (Hayes and Jaikumar, 1988; Bloodgood and Thacker, 1989; Zailyk, 1989; Costea, 1990; Beatty, 1992). There are two main reasons for these islands:

i) where a company takes a piecemeal approach to implementing information systems, be they administrative or operational.

Efficiency and productivity gains are sought on an individual workstation basis with no consideration of the overall impact on the whole process. In this instance, systems are chosen for optimizing/maximising the local situation. This is not always to the optimal/maximum benefit across the board (Goldratt, 1990 and Hayes and Jaikumar, 1988). The most damning indictment of this is the figures presented by Miller (1988) and Zailyk (1989) which show that between 90 and 92 per cent of the time a part is

in production it spends waiting in queues or lying idle. Such figures support Goldratt and Cox's view in *The Goal* (1986).

ii) the lack of open systems on the market.

For example, a British electronics manufacturer visited by the author designed the printed circuit boards (PCBs) used in its products with a CAD system. Actual manufacture of the boards was sub-contracted to an organization which also used a CAD system. However, the two systems were incompatible, necessitating the transfer of hard copy diagrams from source to sub-contractor. The sub-contractor then redrew the artwork using their own CAD system. Such incompatibilities broke the flow of data/information and in some cases led to inconsistencies.

Organizational issues

Hayes and Jaikumar's (1988) description of management attempts to take advantage of new technology provides a useful discussion on the relationship between IT and organizational form. They contend that for new technology to achieve its potential it is vital that management understands the following:

i) the company's existing organizational structure

ii) the existing processes

iii) the potential the new technology offers

iv) the impact it will have on the present organization

v) what changes will be necessary to realize its full potential.

Hayes and Jaikumar argue that, in manufacturing, many attempts to use new technology fail because management does not understand all these aspects

and so attempts to use the new technology in the same way it has used existing technology. Best (1985) has a similar theme when he discusses the manner in which information systems professionals have tried to tackle the problems caused by complexity in the business world.

Much of the literature (Gilchrist, 1985; Hayes and Jaikumar, 1988; Miller, 1988; Shapiro et al. 1992; Gowan and Mathieu, 1993) talks in terms of the "flow of information" through a company. It is argued that those organizations most likely to do well are the ones who share information by allowing it to reach the right people, at the right time (Cook and Eining, 1993; Lincoln and Warberg, 1987; Eisenhart, 1990; Gowan and Mathieu, 1993 and Ayers, 1990). These authors also point out that it is not enough to have a technological solution to ensure the free flow of information; Organizational Form elements must also be in place. For example, whilst installing a Local Area Network provides a mechanism whereby information can be shared, it is of limited value if nobody uses it. This view is shared by Bailey (1983) who maintains that information systems should be designed and built with both the users and the overall process at the forefront of considerations. These factors should not be afterthoughts to the technical considerations.

The following example illustrates this concept of "information flow". The purchasing section of a company agrees to accept delivery of half the materials it ordered a day earlier than originally requested. Purchasing further agrees with the supplier that they will take delivery of the balance in one week's time. However, this information is not passed on by the Purchasing Officer, either by word of mouth or across the computer network, to the Production Manager, who continues to calculate her schedule on the basis of the original order. The Marketing Manager also

remains ignorant of the new reality and confirms the original delivery date with the customer. Incomplete and/or late delivery then causes friction, which may be detrimental to future business, in the supplier-customer relationship.

Best (1985) and Gowan and Mathieu (1993) point out that, in addition to the problems outlined above, many processes are complex and convoluted and that automation can only be successful if the processes are simplified. This requires a sound understanding of not only what management is trying achieve but the various ways in which it can be achieved. Given the quoted figures for the idle time of parts and Miller's (1988) belief that CIM is more concerned with the handling of information than of materials, great gains in productivity should be possible if the flow of information can be smoothed. This can be accomplished if a safe and secure link between the various operations exists.

The Need for Models

Some psychologists and educationalists (Bannister and Mair, 1968; Toffler, 1971; Postman and Weingartner, 1972; Landfield and Leitner, 1980; Nadler and Tushman, 1980; Mancuso and Adams-Webber, 1982) stress the importance of models to make sense of human beings' complex concepts and environments. Nadler and Tushman justify the use of models in the context of organizational behaviour as, " . . . a roadmap that can be used to make sense of the terrain . . . " (p.36) and believe that such a model will show the most important factors, their relationship to each other and which factors will cause the other factors to change. This

aligns, in general terms, with Kelly's Personal Construct Theory (Bannister and Mair, 1968; Landfield and Leitner, 1980; Mancuso and Adams-Webber, 1982) which contends that an individual builds models based on a number of personally formulated and inter-related constructs to make sense of his/her world. These models are also a basis for the individual to predict likely outcomes for specific events. When an individual does not have any model (set of constructs), or one that has become obsolete, for a given situation, he/she tends to find the experience extremely traumatic. This was the basic tenet behind Toffler's *Future Shock*.

The Need for Metaphors

Postman and Weingartner (1972) devote an entire chapter to the relationship of language and thought, arguing that without language many concepts (or "things") cannot be communicated or understood. The importance of this cannot be overstated. When the author taught eight-year old children he noticed that it was important to use words and phrases which were already familiar to the children. If the children lacked the vocabulary to deal with new concepts, it had to be provided and understood before further learning could take place. Postman and Weingartner assert that, "The structure of our language is relentless in forcing upon us 'thing' conceptions." (p.88).

Ott (1989) continues this theme, stating that, "The language . . . becomes the medium through which the perspective's concepts, elements, values, and beliefs are communicated. In this sense, a language serves purposes beyond basic communication. Perhaps most important, language controls cognitive patterns - it affects the way people think about

things." (p.20). Building on the work of Chomsky, Sprinthall and Sprinthall (1981) differentiate between language *performance* and language *competence*. They argue that in language *performance* a person only imitates what is heard, but with language *competence* a person knows the meaning of the words and sentences.

Humans use and combine words in many different ways. Similar words may be used in a different order or context to change the meaning. Different words may be used to communicate a concept previously introduced but not understood by the intended recipient. One of the tools that humans use in language and communication is the "metaphor". "Metaphors are basic to the intellectual processes humans use to determine truth, facts, and meaning . . . They help people organize and make meaning out of experiences." (Ott, 1989). Kendall and Kendall (1993) state that, "Metaphors are the cognitive lenses we use to make sense of all situations. Intimately interconnected with the way we think, metaphors are fundamental in shaping reality." (p.149). They are commonly used by many people as an aid to understanding. As Nietzche (Merali and Martin, 1994; p.1) said, there is, " . . . no real knowing apart from metaphor." However, metaphors often remain invisible, being so deeply ingrained in the use of language. This is the stance taken by Postman and Weingartner (1972) who argue that, " . . . all language is metaphor to one degree or another." (p.87).

Metaphors can, therefore, be helpful in the field of information systems since, as Merali and Martin (1994) state, " . . . we are often dealing with relatively complex and abstract concepts within the universe of discourse." (p.3). They go on to say that metaphors exploit common knowledge and shared experience. Such a base will serve as a general

understanding of the concepts in question. This is closely allied to the belief of Ott (1989) that, "Metaphors help organizations tie their parts together into meaningful wholes." (p.30).

This theme was picked up by Kendall and Kendall (1993) who identified nine metaphor types (Appendix 2) relating to organizational structure. The various systems development methodologies that exist were then matched to the metaphor that seemed most appropriate in an attempt to give an indication of which methodology would be best in a given situation. One of the key points in the article was that the metaphor relating to the organization was very important and should be used to select the systems development methodology to be used. The authors believe that too often systems fail because systems analysts impose a methodology with which *they* are comfortable but which is foreign to the organization concerned, that is, it does not match the way the organization actually operates.

Present IS and Management Metaphors

Many models propounded in IS today also use metaphors as their means of expression. Hence, when Thacker and Bloodgood (1989) state their belief that managers need a tool to envisage full Computer Integrated Manufacture (CIM), they use the term "The Wheel of CIM" to give a conceptual picture. Another example of a metaphor is Checkland's (1990) use of the word "Actors" in his Soft Systems Methodology. Another is the term "Information Super Highway" - made popular by American President Bill Clinton - a powerful metaphor which conjures up a picture of a wide roadway capable of carrying many streams of traffic to many different

destinations. Such a picture is far easier to see and understand than one consisting of many computers and networks, especially since the technical terminology accompanying these can safely be ignored.

In describing the problems associated with the Order Management Cycle (OMC) Shapiro et al. (1992) identify cracks between the functional elements of a traditional organization. These cracks or gaps represent the different priorities, procedures and viewpoints that the various functions have. Shapiro et al. argue that such gaps are detrimental to the performance of a company because they hinder the smooth and trouble-free passage of orders and their related information across the OMC. The author of this paper worked in an organization where there was this kind of gap. Marketing created a sales forecast for Production to use in the building of products. On receiving the forecast the Production Manager promptly threw it in the bin and created his own, on the basis that Marketing had no idea what the market really wanted or what Production was able to give. As can be imagined, this led to a large number of interesting situations!

Shapiro et als. metaphor of "cracks" is complemented by that of the "flow of information". Under this metaphor information is seen to move from place to place, like water, and from person to person, using a variety of means, including computer networks. At each stage of the value chain decisions must be made. The basic operation assumption for many organizations is that 'good' information is required to make these decisions. Much of the information required across all stages of the OMC will already exist before the customer's order has been taken, or will have been collected when the order is confirmed. However, large amounts of this information may stay with the departments which collected it, or

which have claimed ownership of it. In this situation, any other department that requires the information will have to go and find it. This involves duplication of effort and wastes time. The metaphor of an Information Super Highway is useful here, because it suggests that a motorway enables shorter journey times by virtue of a more direct and trouble-free route than an ordinary road.

Limitations of these Metaphors

The metaphors described above enable the reader to create a conceptual picture of some of the organizational problems companies face and how information technologies make possible the transfer of information. However, the use of metaphors in aiding understanding of the role of business processes and their relationship with information systems is somewhat limited. The application of information technologies has not always achieved the closing of cracks or improved the flow of information and in some cases it has made an existing situation much worse. The automated manufacturing environment provides numerous examples of how technologies have widened cracks or impeded flow.

Two examples will suffice here. The first is detailed by Liker et al. (1992) who describes the problems which arise when attempts are made to link incompatible Computer Aided Design (CAD) systems with Computer Aided Manufacturing (CAM) systems. Such occurrences are commonplace and often caused by the lack of open systems. This technology gap prevents the free flow of information between systems.

The second example is from an electronic instruments manufacturer the author worked for. Once a product's design specifications had been finalized and accepted for production, the parts list was handed over to the Data Processing Manager, who then entered the details onto the computer system. From that point on, Design had no authority over the parts list held and any changes had to be channelled through the DP Manager. This slowed the process down and led to deteriorating relationships between the two parties.

In the context of organizational form and the transfer of information between the various functional elements of manufacturing companies, the metaphors "organizational cracks" and "information flow" are powerful. Yet neither metaphor gives explains the relationship between the three fundamental components of an organization, namely: the people, the technology and the organizational form. It is this lack of a conceptual picture that can cause many of the problems encountered with information systems in organizations: companies are still making the same basic error. This error as, Best (1985) contends, is the commonly held view that computers are ancillary to the business, rather intrinsic to it.

Thus, a further metaphor is required to show this relationship. Best proposed the metaphor of IT as the nervous system of the business. Despite the potential power of this metaphor it fails because it introduces additional complexity - the nervous system in higher level creatures being exceedingly complex.

The article 'How Ford is Reinventing the Wheel on a Global Basis' (Buday, 1990 - cited in Reynolds,1992) comes close to a useful metaphor with the concept of a "glue" that sticks geographically separate functions

together. This glue consists of computers and communication technologies. However, the metaphor is limited because it does not explain how the glue holds the various functions of the organization together but merely implies that it does so via the transmission of information; nor does the metaphor give any clues as to what constitutes the building elements (base units) of the organization.

Proposed Metaphor

The metaphor proposed in this section attempts to link the three major elements of any organization (people, technology and structure). It draws on the metaphors discussed in the previous section to a greater or lesser degree and also attempts to link them in a meaningful way. It should enable the reader to envisage how an organization can focus its activities to ensure the integration of all aspects of its operation. However, although the example given is that of a manufacturing concern, the metaphor itself can usefully be applied in other areas also.

It is perhaps useful to use the metaphor in a story in the first instance. In this way the reader can not only consider the metaphor's application to a real life problem but can see how it might be applied in a teaching context.

> Henry Foote the Managing Director of Foote Footwear, a small manufacturer, is facing a problem of declining sales and falling profits. In an attempt to discover the causes of his company's present predicament he calls a meeting with his line managers. During the course of this meeting the various parties all express

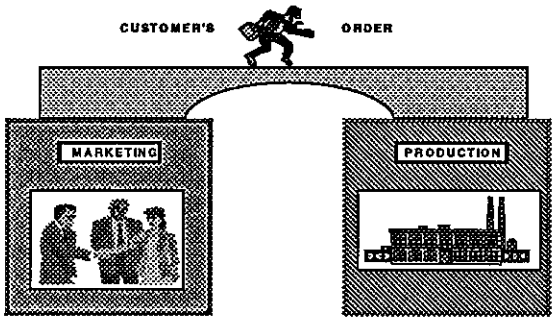
their views on why the company is experiencing difficulties. Many different reasons are offered but the common thread running through the discussion is that each individual function does not consider itself to blame, given the constraints forced upon it by the other functions. Many of the frustrations voiced are of instances where information has gone missing, not been passed on or has arrived late.

Henry Foote finds himself confused as to the real problem or how he can solve it. In desperation he seeks the advice of an old Fortune Teller.

As the Fortune Teller peers into her crystal ball she tells Henry Foote that she sees a fast flowing river, deep and dark, between two steep banks. Across the river a slippery tree trunk is laid. A man, carrying a briefcase, is making his tentative way across this narrow link. As he approaches the far bank the level of the water begins to rise and soon it is swirling around his feet, causing him to lose his footing and plunge into the turbulent river. Then the crystal ball becomes misty and the image fades.

The mists clear and a new scene is revealed. This time the banks of the river are spanned by a glorious bridge constructed from bricks. The same man, carrying the same briefcase, is making his way across its wide thoroughfare. As he approaches the far side, the waters again rise but this time the bridge is strong enough and high enough to resist them and the man reaches the far bank safely. The old Fortune Teller gazes ever more deeply into the crystal sphere and says that there is yet more to see. She tells Foote

that the bridge consists of three elements: the bricks (each of which is a person); the mortar binding the bricks together (consisting not of cement, sand and water but of computers and communication technologies); and the third element is the design of the bridge (its structure), a design which is but one of many possible designs.



Before considering the bridge, it is useful to look at the "banks" of the river and the "river" itself. The banks of the river can be regarded as the functional units (discussed by Shapiro et al.) that are often separated by "cracks". In the proposed metaphor of the bridge these cracks have been replaced by the river. The river represents all those factors that impinge on the progress of information about an order from one functional unit to another. These factors may be anything from sickness in the workforce (for example, the one individual who holds the production plan in his/her head) to a huge rush of orders occurring at one time (which overload the capabilities of the system). The rising of the river represents a culmination of many problems at the same moment.

The man and the briefcase represent the order and its related information respectively. Once the order and its information fall into the river they sink rapidly to the bottom or are swept away.

In practice, the various functions often argue about who has responsibility before they attempt to rescue the situation. Sometimes, this induces critical delays and also prevents rescue attempts from being really co-ordinated, thereby reducing their effectiveness. In contrast, an integrated approach should reduce the likelihood of the order and its information falling into the river in the first place but, if not, rescue attempts should be much more prompt and effective.

As the Fortune Teller's vision showed, the bridge is the means by which the information makes its way through the various processes. The vision also showed that there were three elements to the bridge: bricks, mortar and design. Each of these will be considered in turn.

Bricks (People)

In her studies of pulp mills Zuboff (1990) found that people are the most important asset an organization has. The Japanese concept of Quality Circles recognizes this and gives the workers limited decision-making powers. Western companies who have failed to implement Quality Circles have often done so because they have not recognized the crucial importance of people and have instead maintained traditional management control of all decision making.

The Financial Information Systems (FIS) case reported by Markus (1983) provides an interesting insight into the effect an information system can have. The financial information system introduced, in this instance, created a power battle between two groups of accountants: Corporate and Divisional. The Corporate accountants were supporters of the system while the Divisional accountants opposed it, with one critic saying, "[The system] seems

to [be] running people rather than people utilizing the system." (p.435). Such conflicts create cracks that are not conducive to the free flow of information between functional areas.

When Y_ARD (Yarrow Admiralty Research Department) implemented a word-processing system in 1978 to replace manual typewriters, it also changed the work practices of the copy typists. Y_ARD had three major objectives:

i) to improve the quality of the final typed reports

ii) to reduce its wage bill (the new system required fewer typists)

iii) to improve productivity, that is, to reduce the time spent typing reports

No serious attempts were made to discuss the proposed changes with those directly or indirectly affected. Consequently, the ramifications on affected individuals and on the business system as a whole were not identified. Following implementation, copy typists' job satisfaction fell noticeably, which in turn had a degrading effect on the performance of the overall system. In addition, Y_ARD had to increase the pay of the remaining typists to recognize their increased skills and retain their services. Thus the failure to consider people as integral to the information system resulted in the fulfilment of only the first objective, an improvement in the quality of the final typed reports

The implications for CIM are ominous. For, as Zuboff pointed out, those working with information technology have to be "informated" to take advantage of it, otherwise the technology will never gain the potential projected by its champions. She suggested that automation

of tasks, as the primary reason for implementing information technology, was short-sighted and, in the long run, ineffectual. Such findings are supported by Eisenhart's consideration of Marketing Decision Support Systems. Eisenhart quotes the executive director of the International Center for Information Technologies (ICIT), Peter Keen, who says, "If you put MDSS in the hands of lousy decision-makers, you get lousy decisions." (p.47).

Mortar (Computers and Communication Technologies)

Reynolds (1992) cites the description of computers and communications technologies being the glue that holds an organization together. Shapiro et al. (1992) believe that, "Computer technology is a crucial tool for integrating many steps of the order management cycle." (p.121). Many writers in Information Systems, Management and Education stress the importance of information in decision making. For informed decisions to be made on the basis of relevant information, some mechanism is required to ensure that the information can get from point to point. This is the enabler for "information flow".

Used in the correct manner the technology can ensure the relevant information is speedily transmitted to the next party or parties that require it. Some information may be transformed by a decision at any stage and it is vital that the new information is passed on, not the original information which may be of little or no use in the new context.

Design (Company Structure)

During the course of her vision the old Fortune Teller told Henry Foote that the design of the bridge she saw was but one of many possible designs. Since bridges in the author's homeland of Great Britain are usually built of brick, it was assumed that the bridge in the vision was too. In New Zealand, on the other hand, bridges are built from concrete (for roads) or wire and wood (for footbridges on tramping tracks). The different materials require different designs to take advantage of their particular strengths and minimize their weaknesses. It should be noted, however, that the same materials may also have different designs available to them, as in the case of the steel bridges at Iron Gorge in England and the Firth Of Forth in Scotland.

There are a range of organizational forms available to companies in the same way there are numerous designs available to bridge builders. In their paper 'Information Technology and New Organizational Forms: Destination but no road map' Lambert and Peppard (1993) consider organizational form to consist of structure, systems, management styles, cultures, roles, responsibilities and skills. This definition goes beyond merely considering whether an organization is arranged in a hierarchical manner. It allows scope for other variables to be considered; something that is both desirable and necessary. Furthermore it does not invalidate the findings of Handy (1985) that, depending on their priorities, different types of people prefer different types of organizations.

Conclusion

It is not the intention of this paper to enter into a debate as to whether there is, or should be, a single correct type of organizational form. For the purposes of this paper it is accepted that many different forms exist with different degrees of success. The classifications provided by Handy (1985) and Kendall and Kendall (1993) are a useful conceptual guide to organizational structures.

Nor is the paper designed to give full consideration to the various types of information systems or methodologies. Instead, its major thrust is to suggest a metaphor that can be used to see how the three major components of a computerized (or indeed any) information system fit together.

Manufacturing literature, almost as a matter of course, states the importance of all functions working together in a co-operative and co-ordinated manner towards the set goals. Muhlemann et al. (1992) argue that, "Separation of . . . functions or a reduction of their inter-connections increases the likelihood of disaster . . ." (p.5). This is especially ironic given that many of the systems in manufacturing use today have created "islands of automation" and/or "islands of information" that are not conducive to the integration of the various steps or functions. This lack of integration suggests that these technologies, by their very nature, will *decrease* the likelihood of success. Some of these islands of automation or information have been created by a dearth of open systems architecture; others have been created as a result of the automation of existing processes based on the traditional division of labour across functions.

Today's manager is expected to deal with rapidly changing internal and external environments. Information systems are an integral part of these changes in both environments. There is considerable pressure on managers to take advantage of the opportunities offered by IT. Daniels (1993) believes that, "New managers should have business and technology acumen." (p.128). She makes the case that all functional areas should view themselves and others as co-operatives rather than competitors. This is important given that local efficiency in one function does not guarantee global efficiency for the whole company.

The problems pertaining to the lack of integration across systems and information transfer are illustrated by the metaphors of organizational cracks and the flow of information. These metaphors enable the manager to view the challenge ahead clearly and simply. What they do not do, however, is give the manager any clue on how to address these issues with the tools at his or her disposal. The metaphor of the bridge is designed to provide this clue because it draws attention to the relationship and connectivity of the people in the organization, the organizational form within which they operate and the technology that contributes to their effectiveness, or otherwise. While the metaphor has been applied to a fairly complex (but common) manufacturing example, the author believes it can be used in all fields of information systems.

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Appendix 1

1. Order planning
   - sales forecasting
   - capacity planning

2. Order generation

3. Cost estimation and pricing

4. Order receipt and entry

5. Order selection and prioritization

6. Scheduling

7. Fulfilment
   - procurement
   - manufacturing
   - assembling
   - testing
   - shipping
   - installation

8. Billing

9. Returns and claims

10. Postsales services

Appendix 2

Metaphor

1. Game
2. Machine
3. Journey
4. Jungle
5. Family
6. Zoo
7. Society
8. War
9. Organism

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