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Using the Sociotechnical Approach in Global Software Developments: Is the Theory Relevant today?

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Abstract

Global software development teams are highly dependent on technology for daily activities and production. Researchers have investigated the areas such as communication and time-zone difficulties when working across global boundaries during the last decade. However, this research explores job satisfaction, efficiency and the quality of working life of people working in a medium sized globally distributed software development organisation. It is assumed that the work structures of organisations of today are influenced by the theories from the past. This paper focus upon the issues that faces an Australian organisation involved in global software development, the research compares and contrasts the feelings of the employees using a Sociotechnical approach. The discussion highlights several problems areas specific to the organisation which will lay the foundation for future research.

Keywords

Software development, Sociotechnical, virtual and organisations.

INTRODUCTION

The globalisation phenomena has had a major impact upon the Information Technology industry, it has allowed for IT global outsourcing of service provision and development, software development, helpdesk support to occur in real time on a twenty four basis. The benefits of operating in a global environment appear obvious, with organisations having access to specialised skills within a global workforce, a cheaper labour market and the capacity to operate around the clock, some important challenges remain. The monetary savings that Global software developments allows has been a major driving in its global impact, but global software developments have the problems of dealing with cultural diversity of both customers and colleagues; inadequate communication using technology in place of face-to-face discussions; time differences that cause delays and knowledge management issues that can impede the development of a common understanding (Hanisch 2004; Rezgui 2007). Although these are serious business issues, not enough research has focused on the impact these issues have on the job satisfaction of individuals working within this environment. Technology has enabled a global workforce but have social issues and the quality of working life been considered adequately?

These questions were asked at a coal-face in Britain nearly six decades ago. Some interesting, if not obvious, answers were found which laid the foundation of the Sociotechnical approach to work design and technology (Trist and Bamforth 1951). It was established that people's behaviour was so closely connected to work structure and technology that it was imperative to consider all three aspects in the effectiveness of an organisation (Pasmore 1988). Productivity and motivation are closely linked but monetary rewards are not enough incentive for employees and do not lead to job satisfaction. The ways organisations and jobs are designed is more important in providing for employees' needs. For example, the greater cohesiveness of the team - the greater the satisfaction is for the individual (Trist and Bamforth 1993). The sociotechnical systems concept includes urging designers to create tasks that lead to holistic products and leave scope for employees to set their own standards and means of production. An over reliance on technology can create human problems if there is an imbalance between the social system and technology (Argyris 1960; Pasmore 1988; Trist and Bamforth 1993).

The paper discusses the motivation of the research, the paper then discusses the literature review pertaining to the research area and introduces the concept of sociotechnical approaches and also key design methods based upon this approach. The paper then introduces the Australian case organisation and then applies the sociotechnical approach to analysis the real life particular organisational issues that they are facing. The paper takes a theoretical stance to solve real life issues which will result in organisational outcomes having a direct real life bearing upon the organisation.

MOTIVATION

The business entrepreneurs, who saw the opportunities made available in the new global software market, were confronted by a fiercely competitive and dynamic market. These trends, in conjunction with advancement in technology, have produced more dynamic organisations that are capable of quick reaction to the changing market. This paper concentrates on a multinational, high technology-centric organisation involved in software development. These types of companies are usually founded by an initial designer who creates a successful initial software package and from the success of the initial software packets, new software is developed, these organisations have a history of adopting new and innovative technology solutions. The companies that were successful and experienced rapid growth in the 1990s are now mature organisations. They rely not only on technology but also on a global workforce that, due to time-zone differences, is available for production around the clock (Keen 2002; Lee-Kelley and Sankey 2008). The Internet, which is now integrated into business and personal lives, allows teams to work together on projects across global boundaries. This has enabled organisations to access specialist skills and knowledge where they globally reside, and, utilising a workforce on a global scale, enables them to be more competitive (Georgantzas 2000; Leimeister, Weigle et al. 2001; Niederman, Kundu et al. 2006). The work design in global software development teams, as described above, is highly dependent on technology for daily activities and production. The complexity and issues associated with software development require a certain amount of contextual understanding and creativity. Considering the identified problems, it is reasonable to expect that people working together in a technology dependent environment will experience a certain amount of strain (Niederman, Kundu et al. 2006). People accept but not always appreciate technology as integral parts of their jobs. Has the Sociotechnical approach to work design that promised so much in the 1960s and 1970s, influenced the work structures of globally distributed software development teams of today?

Research into global software development, where team members are typically several steps removed from each other, is emerging. However, studies of operational effectiveness with a focus on job satisfaction and the quality of working life of team members operating in this virtual mode appear to have escaped attention. To progress our understanding of the problems faced by a remote workforce, the initial research reported in this paper explores the employees in a successful medium sized software manufacturing organisation where the development teams are distributed either just on the next floor or around the world and determines the organisational issues that can arise.

BODY OF LITERATURE

The following section will look at some key issue and factors that impacts global software development. It has been suggested that researchers in such domains must be prepared to draw from a range of theories (Rolland and Prakash 1999; Trauth and Jessup 2000; Benbasat and Zmud 2003). In this section we move to an initial brief investigation of several such domains.

Teams and Global Software Development

Projects and tasks are generally assigned to teams based upon the organisational strategy, e.g. the software being developed has an organisational role or purpose.. The amount of work in the allotted time is greater than one person can achieve and the required knowledge and skills are more than one individual possesses. Further, there is a notion that a wide breadth of knowledge is able to produce higher standards and quality in the end products (Shaw 1981). Most tasks require good coordination and collaboration of all members. However, some say that this increase in cognitive power sometimes leads to a whole that is less than the sum of its parts. Sources of failures of team production include poor communication, inadequate situation assessment and pressures to conform (Orasanu and Salas 1993).

Studies on small groups tend to examine the internal state of the individual; attitudes, values, personality and thought that influences personal social behaviour. Early research in this area is focused on the development of groups and is described by Tuckman (1965) as phases of *forming* (task identification) *storming* (interpersonal conflicts) *norming* (conforming, cohesion) *performing* (productive, goal attainment) and *adjourning* (dissolving the group) (Tuckman 1965). The decision-making process in small groups can therefore be viewed as phases of orientation, conflict, emergence and reinforcement.

The literature on global teams naturally focuses of the problems of communication across space and time (Herbsleb and Mocus 2003). Studies of multinational teams are primarily focused on trust (Jarvenpaa, Knoll et al. 1998) and culture differences (Burn and Ash 2000). The literature suggests that there is a strong connection between successful knowledge sharing and trust (Franke 2000; Pavlou 2002) which makes the topic important to industry. Damian and Zowghi (2002) described the challenges of global systems developments in an insightful model. This research identified four major problems: *Inadequate communication*, lack of informal face-to-face communication, the inadequacy of electronic communication tools and exertion of influence and power; *Knowledge management*; information not shared and distance exploited in power games; *Cultural diversity*;

language and national and organisational culture. It was found that remote units developed their own culture, reducing common understanding; *Time difference*, work schedules were compromised and there were delays in responses. Their model provides an insight into the issues and problems that are likely to be encountered during the global development phases such as lack of common understanding, local context, trust and the ability to share work artefacts (Damian and Zowghi 2002).

Global teams use a variety of tools and technology such as phone, video conferencing, email and groupware (Carmel 1999). The Majchrzak, Rice et al. (2000) study show how a collaborative technology tool such as an Internet Notebook was successfully adopted by the team. This research, contrary to Damian and Zowghi (2002), found that a lot of time was saved for the experts using this tool by not having to attend face-to-face meetings (Majchrzak, Rice et al. 2000; Cubranic, Murphy et al. 2005). They were committed to the team from the onset and happy to adjust and adapt their work practices and organisational structures to make the development successful.

Organisational Characteristics and Behaviour

Definitions of the organisation come from law, economics and popular understanding of the subject. A general definition (as per Drenth, Thierry et al. 1998) sees an organisation as: a group of people intentionally organised to achieve an overall, common goal or set of goals; in which work is split into different tasks (specialisation and differentiation); where integration of activities takes place by means of formalised rules and hierarchical management structures with a certain permanence in time (Drenth, Thierry et al. 1998). There are four agreed common characteristics to all organisations: hierarchy of authority, division of labour, coordination of effort and a common goal.

There are four traditional approaches of and in organisations: scientific management (Taylor 1911), the bureaucratic tradition (Weber 1956), the human relationship approach (Mayo 1975) and the scientific administration approach. Scientific management is a concentration on repetitive tasks where tasks are broken down and regrouped to give the highest level of productivity. Time and motion studies also assist in the design of machines. The bureaucratic organisational structure cited in classical management theory emphasised the hierarchical arrangement of authority represented in the familiar organisation charts. In purely bureaucratic forms, activities take place in grouped tasks (Weber 1956). The human relation approach shows that the larger and more complex the organisation is, the more dependent it will be on the cooperation of the members in the group. The Hawthorne effect changed normal leadership style. The studies can be summarised as follows:

- An organisation is a system; changes affect the whole organisation.
- The organisation not only produces goods and services but also output and revenues to the staff members.
- A continuous evaluation takes place within the organisation. Changes are evaluated for social and status for the individuals.
- Individual behaviour is not guided by economic motives alone but also values, opinions and emotions.
- Personal relationships create an informal structure alongside the formal structure. The informal structure has considerable impact on individual behaviour (Drenth, Thierry et al. 1998).

Organisations and structures can be classified according to a range of environments differentiated by degree of predictability and stability. Mechanistic systems broadly resemble bureaucratic models where there is centralised knowledge, clear hierarchy, task specialisation, vertical communication, formal structures and decision making, values and rules in a stable predictable environment. An organic system, in contrast, is less bound by traditional structures and roles. There still are a general hierarchy, dispersed information centres, horizontal (lateral) communication, expert positioning, ethos and practices and more flexible tasks and rules in a changing environment, uncertain markets, complex technologies, continual innovation (Thompson and McHugh 2002). It can be argued a centralised organisation should have mechanistic characteristics and distributed and virtual organisations organic characteristics.

The Sociotechnical Approach to Work Design

The sociotechnical approach to work design is discussed here as a method to evaluate how technology, organisational structures and work designs have influenced the human values and social aspects of working lives in software development. The sociotechnical systems approach focuses on the notion that organisations are

“...made up of people (the social system) using tools, techniques and knowledge (the technical system) to produce goods and services valued by customers (who are part of the organisation’s external environment)...”

(Pasmore 1988). Research revealed that organisational design has the potential to greatly affect the productivity and satisfaction of its members. Moreover, the studies showed that the connection between work design and human behaviour was so tightly connected that it was not possible to understand the human system without understanding the technical system and any changes to either system would affect the other (Trist and Bamforth 1951). Trist referred to this as an open system (i.e. systems theory in biology) which is dependent on its environment for survival. Fundamentally, organisations have to efficiently convert inputs to more desirable outputs than their competitors and it is this transaction process with the environment that forms the beginning of the sociotechnical systems model (Pasmore 1988).

The sociotechnical design approach is a description of procedure and humanistic principles that guide the process of change. Fundamental to the method is the belief that the system should be able to make improvements to work situations and provide better job satisfaction. To achieve a better quality of working life both the technical and the human factors should be considered equally in the design process. Too often the technical systems were considered in isolation of the people who had to utilise them in their daily tasks. Furthermore, the sociotechnical design process also had a democratic factor. The employees who would be affected by the new system should participate and be involved in selecting the components of the improvements (Mumford 2006). It was thought the greater the involvement of employees the better the design would fit the unique characteristics of the organisational members and their tasks and further, that this would ultimately result in increased productivity.

The Organisational Environment

Organisational design evolves over time to take advantage of situations and adapts to an ever changing environment. Failure to adjust to, for example, changes in laws such as trade agreements or consumer attitude and international competition, will eventually see the demise of the company. Some organisations have adopted more flexible strategies to take advantage of this situation and usually create opportunities that escape the more traditionally structured organisation. However, the complexity and turbulence of today's organisations make this extremely difficult (Pasmore 1988).

Organisations based on research and development and knowledge-based product development, which is the focus of this thesis, are experiencing somewhat different problems in adapting to the environment. Purser (1991) explains that high technology companies exist in a slightly different environment and often experience a high level of stress in trying to adapt to the change in demands. The stresses were usually triggered by three events. Firstly, he found that many of these companies were initially founded by "...a creative inventor who was responsible for the successes and rapid growth...". The stress was usually triggered by this well regarded visionary leaving the firm. Secondly, that high technology and knowledge intensive companies usually have complex and different types of structures which make them hard to control and thirdly, trying to remain competitive in a market that is demanding higher quality and faster development cycles. These types of organisations would have to make significant changes to the culture and structure to meet the demands (Purser 1991).

The Technical system

Social systems depend on the technical systems and vice versa. People often develop a pseudo relationship with the machines and technology they operate and find it difficult to imagine life without them. Over time humans have developed mechanistic methods or tools to complete tasks in ways that reduce time, effort and energy to achieve their goals. The technical system includes artefacts, methods, devices, techniques, procedures and knowledge used to transform goods and services to customers (Pasmore 1988). Organisational tasks are frequently structured around the technology, expecting people and the social systems to integrate with the technological imperatives. Organisational structures and policies are usually strategically created at a corporate level to distribute resources as needed. New technologies such as management information systems sometimes result in a structural change of the organisation. Trist and Bamforth (1951) recognised that the technical and social systems were in fact separate and that the two systems could be designed recognising human values as well as the importance of the technology. The importance was stressed that there were choices that should be made in this selection where the humans and technology are most effective. (Trist and Bamforth 1951; Emery and Trist 1972).

Technical arrangement may create boundaries between departments, functions, time and place and thus hampering, for example, spontaneous problem solving. The negative influence the technical system has on performance can be described as the variances or deviances from standard operating procedures. The most obvious example is the inspection function. The sociotechnical framework requires inspections to be performed with production to allow people to learn from mistakes. Analysis has been designed that can identify key variances that are critical to the organisational successes. From this the design teams are able to suggest technical or social system changes that satisfy environmental demands and the social and technical systems

(Pasmore 1988; Cherns 1993).

The Social System

The social system consists of people who have different values, attitudes and beliefs and have standards from which they approach the world. Individuals have a need for learning and growth but traditional bureaucratic structures are not designed to meet such needs. It is thought that bureaucratic organisations destroy motivation of their employees by assuming that they lack the intelligence to make decisions and that all goals and decisions should be made by superiors; that there is one best way to perform any task and differences between people do not matter; that money is a replacement for job satisfaction and therefore the only motivator needed and that the success of the organisation is dependent on how hard people work. These assumptions are thought to lead to behaviours which are counterproductive to running effective organisations (Argyris 1960). It is therefore important to have flexible work structures that reward and fulfil the needs of a diverse workforce.

The sociotechnical systems approach considers formal and informal networks or groups in organisations because most individuals develop a sense of identity by belonging to a group. It therefore makes sense to design effective structures that support and reward the creativity and problem solving activities that occur in groups; however, work designs and tasks need to be considered collectively. Pasmore (1988) suggested that tasks that are unstable and require specialised skills and knowledge are not suitable to autonomous or virtual teams. These groups lack cohesion and leadership and often fail to share knowledge and skills (Pasmore 1988). Furthermore, group cohesion and job satisfaction are more likely to develop when the individuals are able to complete a job from start to the finish. When this is not possible, the members need to link to the other groups to enable them to see the common values of the tasks (Likert 1961; Trist and Bamforth 1993).

Emery and Thorsrud (1969) tested several hypotheses about work and task design. The more noteworthy for this study includes: Finding the optimal mix of variety within the job; Responsibility for setting standards and the importance of receiving feedback; Having a boundary of tasks. Workers will not accept responsibility for matters that are outside their control; Tasks should be worthy within the community and contribute to the product; Interlocking of tasks, job rotation and physical proximity where there is an interdependency of jobs or high levels of stress to help communication and create a mutual understanding between workers (Emery and Thorsrud 1969). As the focus became competition and cost cutting in the 1980s, interest in the Sociotechnical approach declined. However, a few researchers developed the sociotechnical studies further, extending the theory to assist with introduction of computer systems into organisations. Most noteworthy in this area was the work of Enid Mumford.

Enid Mumford and the ETHICS Approach to Systems Design

Enid Mumford, a social scientist, devoted her life to improving the quality of people's working life. She worked in industry before she commenced her research into human working conditions. She was well recognised for her application of the sociotechnical concept to the design of computer-based systems and information technology and, furthermore, developed a method for designing systems which considered the basic needs of the users: ETHICS (Effective Technical and Human Implementation of Computer-based Systems).

Her main focus was on creating an efficient and satisfying form of work structure into which the computer system and the procedures would fit. She recognised that people became frustrated and dissatisfied when they were unable to work efficiently or lack the skills to do so. Often the people were aware of the problems of poor organisation of work and tasks and she felt that the success of a system really depended on the users. If employees felt a high level of achievement and job satisfaction their efficiency and productivity would increase. As they were the people that knew most about their tasks, she developed a participative approach or methodology to computer systems design (Mumford and Henshall 1979). The three main objectives of the ETHICS systems design methodology are to explicitly define the job satisfaction for each employee; to empower employees to influence the design of their own work situations and finally, making sure the new technology supports existing organisational work procedures, individual and group activities, roles and relationships (Mumford 1983).

Mumford defines job satisfaction as the difference between what the employee is seeking from his work, his job needs, expectations and aspirations and what his actual experiences are. A good fit is one that would satisfy the employee's needs. Mumford developed a framework to measure job satisfaction which measures five areas based on Parson and Shils (Parson and Shils 1951): *Knowledge fit*: A good fit exists when employees feel that their skills are being adequately used and their knowledge is being developed. It is difficult for distributed team members to learn from their more experienced colleagues when not collocated (Cubranic, Murphy et al. 2005); *Psychological fit*: The job must fit the employee's status (age etc.); *Efficiency fit*: The effort versus reward (e.g. pay); *Task-structure fit*: Are tasks demanding and fulfilling? Is the task important? Does the employee have the skills required? Does he get feedback? What is the degree of autonomy? Technology can affect the task-

structure fit substantially; *Ethical fit*: Is the value of the employer and employee compatible? Do they agree on quality versus quantity? (Mumford and Henshall 1979; Mumford and Weir 1979).

The second part of the theory relates to participation. The ETHICS approach is fundamentally concerned with managing change and reducing conflicts of interests that may arise during the process. Conflicts need to be openly discussed until a solution that largely fits the interests of the parties is reached. Mumford's method of achieving a better balance in technical and social perspectives goes further than simply adjusting people to technology or technology to people; it is a method of achieving the right balance between them. Computer systems are pervasive in every organisation and Mumford felt that the design of jobs and the interrelationship with technology and the social system is as important as the specification of the system. Her design philosophy focuses on the individual workers and the tasks they perform. The job should be designed in such a way that it creates interest, challenge and responsibility. The design focuses on the input and the quality of the material they have to work with. Job satisfaction is greatly reduced if the input material has errors and needs rework (Mumford and Henshall 1979; Mumford 2003; Avison and Fitzgerald 2006). Mumford (2003) also argues that ETHICS places emphasis on identifying new approaches to tasks and problems and new relationships within and outside the organisation, this is the rationale for using the ETHIC rational in this research context.

This section has provided a review of the literature pertaining to the research into groups of people working on global software developments. The sociotechnical concepts to software development that form the framework for the research are presented as an overview of the method.

METHOD

The human dimension of information technology is centred on understanding the context and impact of information systems and technology. The aim of this research was to gather a rich understanding of the human aspects of global software development teams which are affected by organisational work structures and technology in their daily activities. The organisation chosen was of interest because of its technology-centric nature. The technology, that had encouraged the global takeovers and mergers and enabled the teams to work in a distributed manner, was intrinsic to their daily activities. The case study organisation was therefore able to provide an evaluation of the sociotechnical framework, described in the previous section, by analysing how well the organisation performed against the sociotechnical criteria. The organisation was also of interest because of the fact that it was involved in global software development and therefore from an organisational viewpoint understood the advantages and disadvantages that this approach offered.

The explorative nature of the research suggests that the qualitative research method should offer the richness in detail and insights this type of research needs. This research is not meant to be statistically comparable, but rather lay the groundwork for a more controlled investigation in the future. The researcher selected a number of participants from various levels of the organisational hierarchical structure, such as systems developers, middle management and upper management levels, to participate in a series of snapshot case studies from a global software development organisation and pose semi-structured, open-ended questions during interviews. The interview questions were guided by the responses of the participants. Twelve participants were chosen from various countries, hierarchical levels and sections to allow for a range of different perceptions. As the software was developed around a function rather than product type, the interviews were categorised according to the special functional groups such as products management, designing the concepts, developing the code and writing the technical manuals.

RESULTS AND DISCUSSION

The issues that might distract from the effective operation of the organisation were identified by interviewees as being most important, and can be categorised as: Difficulties including all global features in the software, working within a functional rather than product structure, different programming languages inherent in the software and project management problems.

Global Features

Many of the organisational problems highlighted by the interviewees were centred on the organisational structure and product development issues. The upper managerial level of the organisation felt that the global structure of the organisation made it difficult to disseminate the corporate strategic vision throughout the organisation. The Executive Director was aware that goals and new directions needed to be understood and accepted before people would get behind any changes and he therefore paid a great deal of attention to disseminating and aligning the corporate vision, travelling relentlessly around the world to get the message across. He was mainly focused on product visualisation, discussing how he hoped their products should be able to empower and liberate small businesses. The Executive Director further explained that software developments are expensive and that they needed to reduce the development expenses: "... *We are hoping the number of*

product developers will decline over the next few years – we want to achieve operational excellence in that area...". To translate this into tactical and operational plans, the emphasis had shifted to developing software with inherent global features that could be distributed to multiple markets and there was a furtive expectation of downsizing within the organisation. The organisation was aggressively growing a technical workforce in Malaysia with the view to move software programming offshore. As the director of the company explained, the top developers in Asia earned half of the salary of their US peers.

Some people felt the "...organisation's obsession with global software designs..." was causing several problems in addition to scarcity of resources. There was a general consensus at the two lower levels of interviewees that global software development was inappropriate at times. The local market, culture and legal aspects needed to be understood and included in the design. Such country specific features required local skill and knowledge and it was felt that these features should be designed and written locally. For example when the Australian group was designing software features that would appear in a global release they needed to reach agreements from all the different markets. Reaching a consensus meant extensive global discussions. Communication was delayed by time-zone problems which were frequently compounded by the subjectivity of messages. Often one team would become frustrated and go ahead with *their* design disappointingly ignoring the input of others. The limitation of support and technology to carry out their jobs efficiently appear to have reduced job satisfaction. Not surprisingly the communication issues were the most frequently reported source of discontentment within the organisation.

The functional structure of the technology group had been introduced in 1999 to leverage the expertise and resources scattered around the globe. The CEOs were committed to this structure and newly acquired groups were gradually being introduced to this mode of operating. The corporate vision was clearly understood throughout the organisation but implementing the strategy and working within the organisational structure was creating a number of issues for the operational staff and the functional managers. The feeling was that the global development processes of the organisation had become unworkable several years ago. The jobs of software developers inherently have high levels of creativity and a need for interactions but the arrangement of only working on sections of software features had led to a working environment that could be described as a production line process. It is established that work group designs are best suited to situations where there are no barriers to communication. Groups that come together to work on individual projects do not have time to create trust and stability and, furthermore, do not have opportunities to learn skills of other group members. Projects that need a high degree of knowledge specialisation and variability of tasks are not well suited to autonomous work groups. Groups that are unable to focus on a common task or a goal are less likely to connect and members may therefore seek personal rather than group-based rewards (Pasmore 1988). Individuals who are able to complete a job from start to finish are generally more satisfied with their jobs than people who are only able to work on small sections of the projects (Emery and Trist 1978). The individuals in the case study organisation felt devoid of the gratification of seeing their work completed. Sometimes it would take months before they would work on the same piece of software if at all and, one can only imagine the disappointment if their input had been scrapped without any further communication. The new staff was fiercely protective of their contributions which were described by some as "*people's egos getting in the way of good design*". However, having exhausted their creativity the need for job satisfaction or a sense of achievement would occasionally take precedence and they would therefore focus more on personal feelings and interests.

One particular piece of software had been designed and developed by a single group and the ownership and pride in the product had been inspirational. However, the reality that it had been produced by a single group working around a particular product development appears to have been lost on the organisation. Further to Emery and Trist (1978), Trist and Bramforth (1951) originally suggested that there are various interdependencies between tasks and workers and that performing a "whole" task as a group can better satisfy the social and psychological needs of its members. Pasmore, Francis et al. (1982) supported this view and added that work systems that are able to contribute as an integrated whole tend to place more importance on the overall achievement rather than on individual needs. Such groups are deemed more efficient and flexible (Pasmore, Francis et al. 1982).

The functional structure of the organisation was created to deliver a quality product in a competitive market and utilising their workforce around the clock obviously made economic sense. Despite the criticisms and disadvantages of the global working environment the organisation did produce quality software on time at a competitive price. As the competition increases the organisation is planning to move development into a cheaper labour market in Asia thus responding to the external environment. The organisation was committed to the functional structure as the "one best way" and adhering to a bureaucratic model that may risk the quality of working life.

Different Programming Languages

Davis & Taylor (1972) discussed the notion of work hierarchies and warned against having an over specified work design (Salvendy and Karwowski 1994). Expert skills are scarce and it is not economically viable to have specialist in all sub-groups. Fred Emery (1978) formed the idea of 'redundancy of functions' or multi-skilling as it is called today. He suggested that groups should work together on a number of different tasks to leverage the skills to all its members (Emery and Trist 1978). Such work groups would be more reliable as they were available to work on any projects. A number of issues were highlighted in the case study that related to scarcity of skilled resources. The takeovers and mergers into the organisation had produced a range of software products having a multitude of different code bases. Locating available developers with skills in specific programming languages created both resource and technical constraints on production. The global head of development was well aware of the skill shortage and was taking steps to increase the knowledge and skill base of the company. He felt that by moving staff between countries staff would not only share their knowledge but also develop cultural appreciation and trust. This strategy was received optimistically across the organisation. Staff repeatedly stressed the importance of meeting face-to-face and *knowing* the person they were trying to communicate with.

Project Management

The issues of communication were not confined to the global structure of the company. The functional development structure of the organisation was causing problems across all areas and apparently made it difficult to manage the various projects. Traditionally the product managers, who had financial incentives, would not only raise awareness of new product developments but they would also make sure their product was moving through

the software development cycle. Interestingly, there seems to be a disagreement as to whether project management was the responsibility of the product managers or not. It appeared that there was a strategy to "...*lift product managers out of the development area to allow them to concentrate on the customers and selling...*"

However, this meant that the developers did not know what projects were coming and what features the designers were working on at the moment. Furthermore, the quality assurance testers and technical communicators, who were the last in the development cycle, would be seriously short of time before release dates if they were not involved. Writing testing scripts and developing manuals are activities that should be running parallel to the development. They could not risk finding bugs at the end of the development cycle as this would not leave enough time to develop patches, more testing etc.

To disseminate knowledge teams would therefore have weekly meetings involving all functional areas. The team leading the development cycle would initiate and host the meetings and as the project moved through the cycles the next team would host the discussions. As each member might be working on several projects there were quite a number of meetings to attend every week. Moreover, most of the meetings involved teleconferencing with team members in different time zones and the meetings would therefore be scheduled around small windows of communication opportunities. Most of these problems originated from the functional structure of the organisation but this was repeatedly conveyed as project management problems. The organisation was in the process of implementing a new project management tool and although it was expected to make them slower to market, was expected to help resource planning and communication.

CONCLUSION

The objective of the research question was to explore the software development cycles with a view to understand how technology and work structures have been influenced by the sociotechnical philosophy and determine the issues that can arise from cultural or time differences. The organisation within this research is in a fast moving industry with strong and worldwide competition and the emphasis was placed on price and speed. The organisational design was an *ad hoc* development but the global nature of the organisation had led management to introduce a functional structure to software development rather than the traditional structure of teams working around a project. Many of the organisational issues stemmed from this work structure such as communication and cooperation, efficiency, team spirit and job satisfaction.

The hierarchical structure of the organisation meant that work designs were imposed by management with no participation from the people at the production level. The staff at this level were concerned with the inefficiencies of working in this manner and, although they were operating within the set boundaries, they were offered little reward or incentive. Consistent with research into high technology companies this organisation was showing signs of identity crisis symbolised by the larger more differentiated and technically complex organisation and the stresses of competition (Purser 1991). Several of the interviewees commented on the outdated structure of the organisation.. Also highlighted was the specialists need for view of the whole which is difficult to provide in highly differentiated hierarchical organisations. Under these conditions decisions are often made without understanding the impact on other departments and interrelated issues (Drucker, Nonaka et al.

1998). It is clear that this organisation has not considered the impact of technology on the social aspect of the staff. Some aspects of the sociotechnical approach, such as skill sharing, were escalating. The employees were resigned to using the technology made available to them but they were frustrated by the inefficiencies and this was evidently affecting job satisfaction. The interviewees on the lowest level of the organisation expressed many suggestions on how the organisation could be better structured for efficiency and creativity. There was no evidence that the sociotechnical approach to organisational design was considered in the global work structure in this organisation. It is hoped that this research is able to raise questions about the efficiencies and perceived cost saving of having a globally distributed workforce.

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