

Changes to the Organisation and Work of Managers following the Introduction of an Integrated Information System.

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Abstract.

The developments that have taken place in computer technology, such as the development of "integrated" as opposed to "stand alone" systems, are predicted to have implications for both the structure of an organisation and the role of managers. However, empirical research on the effects that integrated computer based information systems have on managers and organisational structures has remained a relatively neglected area.

The authors have recently completed research that has gone some way towards addressing this deficiency. The work developed out of some earlier research into the nature and extent of Computer Integrated Manufacturing (CIM) in the North East of England and was carried out jointly between the Department of Computer Science at the University of York and the Department of Applied Social Science at the University of Northumbria at Newcastle. Its aim was to explore, through a detailed examination of the experiences and opinions of managers who use integrated information systems, the nature of the changes that occur in organisations employing such systems.

The work is based around eight case study companies in the North East all of which, in their own way, are at the leading edge of the development of integrated information systems in the Northern region. Its overall aim was to examine how social processes shape, and are shaped by, the introduction of such systems.

The primary method of data collection used was in-depth semi-structured interviews. The interview schedule was structured around the topics outlined in a previous paper, given at the PICT National Conference in Newport in March 1992, which presented some of the preliminary findings. During the work a total of 65 interviews were performed with the majority of the interviews being conducted with middle and senior managers. Additional information was collected from interviews with Personnel and IT Managers, by short periods of observation and by the examination of related documentary material.

The paper will present some of the findings from the research in greater detail and will focus particularly upon (1) the association between changes in the relationship between different functional areas and (2) the changes that occur in the role of managers using such systems. In particular the paper will explore the links between the functioning of the new systems and the culture of the organisations in question. The paper will illustrate, by use of quotations from the managers interviewed, how in some cases the visibility provided by the systems disrupted the existing culture and how, in other cases, the existing culture interfered with the functioning of the system. It is argued that all three effects must be considered when assessing the impact of Integrated Information Systems. Following a brief discussion of the findings some possible guidelines for those charged with the task of implementing such systems are provided.

1. Introduction.

The following paper describes some of the findings of a two year research project to study the impact of Integrated Information Systems on the skills and responsibilities of managers. The study employed an empirical approach in the Social Science or qualitative tradition.

This work first developed from research, performed in 1987 - 1988, into the nature and extent of Computer Integrated Manufacturing (CIM)¹. The current project was carried out jointly between the Department of Computer Science at the University of York and the Department of Applied Social Science at the University of Northumbria at Newcastle.

Although a detailed review of the literature is not within the scope of this paper the underlying theoretical framework used in the work is sketched out below. This is presented in the form of three idealised models of the impact of Information Technology. Some of the salient features of these three models have been discussed in greater detail elsewhere^{2,3}.

The three impact models formed the basis for an initial categorisation of the impact of the introduction of the new systems. After analysis these initial categories were refined into three classes of outcome identified by grouping together similar examples of impacts from the research data. The findings of the work are presented in these categories.

2. The initial framework.

Although there is now a well established body of research concerning the impacts of computer based systems there has been little work done specifically on the impact of integrated information systems on managers. This seems to be a surprising gap to find in the literature.

It has been suggested, for example, that the organisational impacts experienced when organisations introduce stand alone systems differ substantially from those when integrated systems are introduced⁴. Similarly, although many typical management tasks involve the analysis of data and the collection and distribution of information⁵, little work has concentrated specifically on this group. In this work integrated information systems are taken to mean single computer based information systems that transfer information across both horizontal (functional) and vertical (hierarchical) boundaries in an organisation.

This paper presents the findings of research funded by Northern IT Ltd. The aims of the work were to examine, through the experiences and opinions of managers, the effect that integrated information systems might have in certain specific areas related to management skills and responsibilities. The underlying objective for the work was to study the ways in which integrated information systems interact with their organisational and social context.

The three possible mechanisms for the impact of such systems were used as initial models. These were then revised and refined in the light of the empirical data. The

initial models were first developed from generic models of the link between technology and the social change associated with its introduction. Examples of similar attempts to structure the literature on the links between Information Technology and social change can be found in the work of a large number of other authors^{6,7,8}. The first two models of the impact of information systems on managers are derived from the two static impact models used in the earlier work on CIM.

The first model uses Information Systems as a substitute for labour, in much the same way as "automation" has been used on the shop floor. The central argument is that technology can perform the work of managers more efficiently than a human being. The technology is the outcome of scientific progress and is used to improve some mechanistic notion of "efficiency" such as the speed or the volume of transactions that can be processed. The model predicts that the deployment of Integrated Systems will inevitably lead to the deskilling of managers. As the new technologies develop and become more widespread the role of the human manager is degraded. Their role progressively contracts until eventually it disappears altogether.

In the second model the technology is not the "cause" of an impact, as is the case in the first model, but the agent of intentional change. Social values are effectively built into the technology with the intention of bringing about a certain outcome. The argument is that Integrated Information Systems are a means to improve a more subjective, and less mechanistic, notion of "effectiveness". For example, it is claimed that such systems will free people from the monotony of day to day tasks. It will give them the time, and the information, they need to take a more holistic approach to their work. It is not the technology itself that has this effect but the way it is designed and used. It might reasonably be argued that this model would seem to be the more appropriate for the impact of information systems on managers.

The earlier work on CIM however provided some evidence to support the first model but little to support the second. Perhaps the best example of this was provided by the comments of an operations director who compared the present role of middle managers to that of "sophisticated post boys" and asked:

"Where is the job for a middle manager in 5 years time? ... I see the bottom level of the company reducing in numbers, yes, but I then see a very narrow neck where the middle managers used to be ... I see it as an hour glass shape in the future, with a smaller amount at the bottom than we used to have ... pinching in through a neck at the middle ... and opening out at the top to a wider and flatter plateau with a range of decision makers and people involved with the whole business."

One of the clearest themes to come from this early work on CIM was the range of potential impacts it could have on those responsible for managing it. The issues of greatest concern were those associated with people and their attitudes. The problems respondents identified were all problems associated with managing a change that they fully expected to affect all aspects of their work. The point most often raised was the need to recognise that organisational issues, or human factors, were crucial to the successful implementation of CIM. Practical experience had shown them that a failure to recognise this had proved to be the road block to successful implementation.

Although there appeared to be some prima facie evidence to support the first model, on its own, it seemed to be inadequate to explain the richness and diversity of the findings.

With this in mind the authors returned to the literature dealing with the impact of information systems. It became apparent that a third school of thought existed that provided an alternative view. This formed the basis for a third model of the impact of information systems incorporated in the research design.

The two static models outlined above portray simple linear impacts: unstoppable technical advances impacting on existing social practices or the wilful use of a technology to achieve some desired social goal. The third model takes a less deterministic approach. Strictly it should not be called an impact model at all as there is no real concept of "impacts" within it. It is based on the concept of the organisation as a social entity. It models the "impact" of technology not as a single outcome but as a complex and interactive ongoing process. It asserts that the outcome at any one time both shapes future outcomes and is shaped by what has gone before. The principal mechanism for this is the interactions of groups of people, or individuals, free to act within the constraints of their current milieu. Specific features of the technology, and the nature of any organisational change, are only two of several interrelated factors. Technology does not "impact" on its social environment but, over time, each shapes the other. In this sense the model is not a linear model but a chain or a web model⁹ where the role of the technology is simply as one medium for social interaction.

The concept of culture proved to be a particularly useful tool when describing this form of dynamic and processual model of the impact of a new technology. Culture can be seen as an expression of social reality¹⁰. It can be seen as both cause and effect: the shaper of human interactions and the outcome of them¹¹. In particular culture, as corporate culture, can be seen as an expression of the shared social values and meanings that describe an organisation.^{12,13} Finally culture, as a set of cultural artefacts, such as rituals and ceremonies, can also be seen as having a direct link to the broader concept of technology as "the way in which things are done"¹⁴.

3. The methodology.

The objectives of the research and the underlying model are outlined above. The research design had the following features.

- The same definition of an Integrated Information System was used in this work as was used in the earlier research on CIM, i.e. a single, computer based, Information System that transfers information across functional (horizontal) and hierarchical (vertical) boundaries in an organisation.
- The primary method of data collection was in-depth, semi-structured, interviews in a number of case study companies.
- The underlying models used to structure the interviews were those outlined above.
- The case study interviews were recorded and transcribed.

- The managers interviewed in each case study were drawn from a number of different levels and functions within the company.

In all over 50 companies were contacted from which eight case study companies were identified. A letter was sent to each organisation outlining the nature and aims of the project, how the work would be conducted and asking if they wished to be involved in the project. Those who responded positively were then visited as part of a preliminary screening process. If the company wished to be involved in the work, and if it had an integrated information system, the company was asked to provide a small sample¹⁵ of managers from different levels in the hierarchy and functional areas¹⁶ who used the system.

The data was collected using in-depth, semi-structured, interviews. The interview schedule was based around topics agreed with the sponsoring body and drawn from the previous work on CIM, a literature survey and the three models outlined above. The interviews were tape recorded and transcribed. Interviews with other managers to provide contextual information, short periods of observation and the collection of documentary material were also used.

In all 65¹⁷ interviews were performed, 31 in service industries and 34 in manufacturing. The majority of the interviews were with middle and senior managers. Over 60 hours of interviews were recorded. Over 2000 pages of transcribed interviews were produced. A variety of documentary material was also collected, in one case spanning a period of several years.

The procedures used in the analysis stage were developed from the earlier work on CIM and broadly follow those suggested by Tesch¹⁸. The analysis took place in two stages. The aim was to develop a set of reasonably coherent and homogeneous categories of outcome that appeared to share underlying similarities. The analytical phase was therefore essentially a process of developing and refining a new classification of the data beginning from the initial set of categories derived from the literature.

The first stage set the initial conditions for the analysis. The interview transcripts were split into two, roughly equal groups, with each researcher taking one group. Working individually each researcher coded the transcripts using the original research questions. This was then developed and refined during the remaining stages of the analysis.

Once the initial conditions had been set the remaining analysis consisted of an iterative process of examining the current set of classifications to see how well they explained the set of observations of "common themes" derived from the research data.

The researchers met, swapped their transcripts, and applied the coding framework across their data set looking for commonalties and emergent themes. Each example of a section of text that had been given the same code was collected together and compared. The researchers then met again, the newly coded data set was examined. The researchers then discussed any emergent common themes which might form the

basis for a new set of categories. Once a new set of categories were agreed the process was repeated until both researchers were happy that a representative framework had been established. A quantitative "check" of the accuracy of the categorisation, in the form of a simple count of different issues raised, was also used in this stage.

4. The case study companies.

The following summarises in table form the key features of the case study companies. It shows (1) if the case study is a manufacturing or service industry, (2) the type of system they used, (3) some details of the ownership of the company and (4) the scope of the company's business.

Case	Industrial sector	Type of system	Owner - Nationality (Sector)	Scope of business
A	Manufacturing	MRP	US (Private)	International
B	Manufacturing	MRP	UK (Private)	International
C	Service	CSS	UK (Private)	International
D	Service	CSS	UK (Private)	National
E	Service	Network	UK (Public)	National
F	Manufacturing	Network	UK (Private)	International
G	Service	MIS	UK (Private)	Regional
H	Manufacturing	MIS	UK (Private)	International

Key features of the case study companies.

The type of systems that featured in this work are briefly described below.

MRP

Manufacturing Resources Planning systems are a suite of sophisticated packages that incorporate both the planning of capacity and the scheduling of production operations into one system. MRP II attempts to integrate the planning and control of all major manufacturing resources in one comprehensive computer based system.

MIS

A **Management Information System** is computer system, or related group of systems, which collects and presents management information relating to a business in order to facilitate its control.

CSS

Customer Service System. A computer based information system used to provide information about customers at point of contact. Typically these systems also produce a set of statistics for use in the management of the business.

Network

Strictly speaking a network is a generic term for a computer based communications system between two or more machines. In the case study companies these were a

LAN or **Local Area Network** and a WAN or **Wide Area Network**. LAN's are computer based communication networks that connect devices within a clearly defined area, such as a single building or a group of adjacent buildings, through a common cabling system. WAN's are networks that a company uses to distribute data around sites various sites that may be scattered about either a single country or the world.

4. The Findings.

The overall aim of the work was to examine how social processes shape, and are shaped by, the introduction of such systems. We have presented the three models of the impact of information systems that formed the initial structure for the work and explained how the methodology we adopted lead to a refinement of these initial categories based on the findings from the field work. The presentation of the results reflect the final categorisation that emerged from the analysis.

4.1. New Systems Shaping Changes in Existing Culture and Practice.

The use of Integrated Information Systems clearly had an impact on the work of most of the managers in our study. The specific requirements of the particular systems frequently had the effect of enforcing a more rigorous and formalised discipline upon them. This effect was particularly obvious at middle and junior levels of management. A purchasing director in company A contrasted the old way of working (Company One) with the way in which things are now done (Company Two).

"... if you going to put the lot on a machine you have to have formal procedures about who does what ... you will have much more formality in Company Two. The first thing you have to instil into people is the need for procedures ... there are certain things that must be done and they must be done in that way and they must be done on a regular basis."
(Purchasing Director, Case A.)

The introduction of these such systems was, in most cases, also accompanied by a shifting of accountability and responsibility down the organisational hierarchy. The same director explained that one objective of the system was:

"... to force responsibility and accountability down the management line ... we saw MRP II was going to enable us to do that because everyone was going to be part of this system and we could put the accountability where it really belonged." (Purchasing Director, Case A.)

However, in contrast to what might be expected, three out of four managers did not see themselves as being "de-skilled" or that the systems posed any particular threat to their jobs.

In general managers were in favour of the new systems primarily because of the information they provided and the time they saved. For example,

"I think [the advantages are] quickness and easy access to the information that I need ... if I want to check a delivery address I just go to the computer and I've got the address straight away, I don't have to search for the address in files." (Shipping Manager, Case B.)

Many of the managers we interviewed used the phrase "visibility" to describe the ability of such systems to access and distribute information. This visibility was seen as being a particular advantage in their work.

"The strengths to me have got to be total visibility of an order, you know I can't get away from that ... It enables managers to manage more effectively. They have the visibility to do their job more efficiently, they're not up and down chasing bits of paper." (Installations Manager, Case C.)

The lack of feelings of alienation or deskilling, the enhanced visibility given by the systems, and the widespread acceptance of e-mail and messaging systems might be expected to have encouraged a breaking down of inter-departmental barriers and an increase in team working. This however does not seem to have been the case.

Most of the literature in the area tends to concentrate on the vertical dimension of integrated systems. Zuboff¹⁹ for example talks of an "Information Panopticon". She argues that the certain knowledge that any action will be automatically observed by superiors through the "universal transparency" of such systems means that people will effectively police themselves. Others, such as Applegate²⁰, argue that increased access to data, effortless supervision and improved communications will facilitate the de-layering of the organisation. It seems to be almost taken for granted that better communications and access to a common source of data will lead to co-operation and the breaking down of horizontal, inter-departmental barriers. However, taking the case studies as a whole, there were more managers that felt the introduction of the system had led to less co-operation and the raising of barriers than those who felt that it had enhanced co-operation and team-work.

It appears that the visibility provided by Integrated Information Systems lay at the bottom of the comments both about the advantages of the systems and their role as a creator of conflict. In the former information helps managers to do their jobs and in the latter it exacerbates internal stresses already present within the organisation.

This work found two particularly clear examples of how the new systems disrupted existing culture and practices. What appears to have happened in these cases is that the information produced and distributed by the system eroded the informal authority of a traditionally powerful department. These departments had, because of historical circumstances, enjoyed a pivotal position in the functioning of the company and had built up a base of informal and unquestioned authority.

Case Study A provides the first example. Company A produces chemicals for the pharmaceutical and agricultural industries. It is a tightly knit, relatively young company with a low staff turnover. A large proportion of the middle and senior management have a specialist technical background in Engineering or Chemistry. Historically their business had been built up as a "Jobbing Manufacturer" of Pharmaceuticals. Pressure to increase capacity under tight budgetary constraints, among other factors, led to the decision to adopt MRP II at the site.

Within Company A there had been the unquestioned belief that "production was king". People working in the production area were "the heroes" of the company who could

always deliver the goods when the time came to meet the end of the month financial targets. In contrast the warehouse was seen as:

"... something of a dumping ground. The less able, the less healthy, the older people within the company tended to migrate to the warehouse department." (Warehouse Manager, Case A.)

However with the introduction of MRP II this situation changed radically.

The company had been aware that it was carrying too much stock but the assumption had been that this was due to inefficiencies in the warehousing arrangements. Before the introduction of the MRP system the stock location accuracy was less than 50% which meant that they didn't know where over 50% of the stock was held. It was said that you could always recognise a warehouse supervisor by the crick they had in their neck from permanently walking around looking for things.

In order for the new MRP system to operate effectively this situation had to change. Over time stock location accuracy improved and when the cut over to MRP took place a new system of requisitioning stock instituted. Production personnel now had to follow a predetermined Master Schedule, set by the planning department, and to record accurately their use of materials when and as they used them. After the cut over the warehouse could only release material if it matched the paperwork produced from the Master Schedule exactly.

In the past if production requested material the warehouse had to supply it. This practice had contributed to many of the perceived inefficiencies of the warehouse. What began to emerge was that production had had a somewhat cavalier attitude toward the requisitioning and recording of stock. Full drums of material would be requisitioned when half full drums were already on the site, sometimes material that had not been tested for quality was used and a whole batch would have to be scrapped. In some cases items were removed by production with no controls at all. Reflecting on the previous behaviour of production a director described their attitude as:

"A law unto themselves ... cowboys ... they were out there making the chemicals, everybody else was a hanger-on ... they could do what they liked." (Director of Logistics, Case A.)

Now production was unable to requisition materials whenever they wanted because of the way MRP worked. The result was conflict, not along vertical divisions but horizontally between departments. The situation was described graphically by a planning manager.

"... relations between one of the plants and stores is almost coming to fisticuffs at times ... "You've got the stuff, give it to us" - "No we can't give it to you because the system says you don't need it." - "We f***ing do need it!" So you see ... [managers] ... almost coming to blows about whether or not they need this stuff." (Planning Manager, Case A.)

Only after the system had been introduced did people begin to appreciate the far reaching effects it would have on the socially constructed company culture. Several managers admitted that they had unrealistic expectations of what the system could do in some areas but had overlooked the effects it could have in others. For example,

"I think the thing with hindsight what we maybe didn't do as a company was to really fully appreciate the ultimate ramifications of what we were going to end up with before we started ... all MRP II has really done is to ... highlight the shortcomings of the company which have always been there, its just now we can actually see them." (Master Scheduler, Case A.)

The second example of this type can be found in Case Study G. Company G is a chain of retail outlets. It is a family owned business built on the basis of being able to do "good deals": buying in goods cheaply and selling them on at a high profit margin. A culture had developed in Company G, similar to that in Company A, where the purchasing department were the "heroes" of the company.

"Because the emphasis within the company, with it being a family company built on an entrepreneurial basis, [the] people who do deals, people who buy products, and buy them in at good prices and make the company good margins ... they're the people who have been rewarded." (Company Accountant, Case G.)

Buyers who did not perform incurred the wrath of the Managing Director.

"The greatest crime that any buyer can do in this company is to have to MD walk around and see a bare shelf. If that happens to him it's his career, it's a failure, he'll be in real trouble." (Company Accountant, Case G.)

Case Study G had had EPOS terminals for some time although previously they had only been used to look up the price of goods at the till. Apart for providing prices the only information the system produced were some sales statistics - mainly used by the buyers to produce reports. As part of the modernisation of the company's accounting systems the existing EPOS terminals were linked into a wider stock and management information system so that overheads could be more tightly controlled.

When the new Integrated Information System was introduced, it slowly became obvious that in many cases the buyers were only getting a good deal by incurring a previously unseen cost. What a manager in Company G described as:

"... a classic symptom of ... one department who drive the company to get the results that they perceive are right and leave costs, trails of costs, behind them." (Company Accountant, Case G.)

The system showed for the first time a complete picture of the stock that the company was carrying, the rate at which items were sold and which items were being put on "special offer". It became clear that the warehouse was being filled with goods that did not sell and later had to be discounted and put on "special offer".

Previously, because the system had only been used to send a price to a till, the practice had been that when there was a "special offer" on an item all that was done was to add a new item code to the EPOS database. There was no link between the original item and the "special offer". The result was that many product codes had been duplicated. In order for the new system to work these duplicated codes had to be removed. The problem of fixing duplicated codes was described as a "technical difficulty" but it turned out that the introduction of the new system led to more fundamental problems surfacing. These were described by one respondent as problems of "cultural acceptance".

Previously, like the warehouseman in company A, the position of the store manager carried a low status. Store managers were described as "very much someone to open and shut the store". As with company A the introduction of the system was accompanied by a shifting of responsibility and accountability down the organisational hierarchy. Part of this shift involved store managers being trained in the elements of finance so that they could handle devolved budgeting. The result was that store managers became more accountable and involved with the business. Again, as with company A, the end result was conflict between what were described as "the two big power bases within the company": the purchasing department and the retail managers. Again the result was conflict between functions as the information produced by the new system revealed to one group the practices of another.

Both of the above are particularly clear examples of how the introduction of a new information system disturbed the existing status quo. In both cases the system functioned as intended but the resulting social impact was largely unforeseen. In both cases the root of the problems was what Keen²¹ calls "The Politics of Data". The information produced and distributed by the new systems, together with associated changes in the roles of key personnel, disrupts unquestioned and possibly unrecognised informal power relationships between departments through the creation of a new reality based on the data contained within the system. This work also provided other, less graphic, examples of how people felt the introduction of the new systems might impact on the existing organisation.

4.2. Existing Culture and Practice Shaping Changes Associated with New Systems.

In the above examples the information created by the new systems interfered with the existing company culture and disrupted the shared ideology of its members. This is not always the case. As Cambell and Warner²² pointed out in their study of selected British companies, if an organisation's culture and management demand the perpetuation of a style of working then that is what tends to happen - regardless of the technology. This research also provided several examples of this being true.

The first example concerns the differential use made of the systems by senior and other levels of manager. It was clear from the research that the way in which senior and lower level managers used the systems differed considerably. Middle managers used the systems to monitor the work of the people they supervised and to analyse and create new information. Senior managers on the other hand tended to make less use of the systems and relied upon their junior colleagues to supply them with a paper based abstract or summary rather than extract the information themselves. For example, one senior manager commented:

"Oddly enough I rarely go through the terminal because the information I get comes in on a print out ... which my staff prepare for me ... I have a filter whereby one of the managers knows the information requirements I have and pulls off from a number of different printouts the information I use." (Senior Billing Manager, Case C.)

There were, of course, some exceptions. A few senior managers did make use of the data available from the systems directly. For example some senior managers made occasional use of the system when convenient to do so or when the people who usually operated the system were not available.

"I knew a lot more about working the actual equipment when I had a secretary that packed up at 2 o'clock in the afternoon, where if I couldn't work the equipment, I was stuck for the afternoon." (Regional Manager, Case D.)

In line with the findings of other researchers²³ e-mail and messaging systems were the only exception to this. A number of senior managers said that this was the only thing they used the systems for. In general however it remained the case that senior managers were content to let junior staff deal with "keyboards".

Senior managers frequently saw the potential of Information Systems to remove layers of middle management from their organisations. The practice of using middle and junior level managers to collect and collate information however appears to contradict this implicit objective. Their own limited use of such systems meant that they were still dependent on middle and lower level managers to supply them with paper-based information.

Various reasons were put forward for the low use of systems by senior managers. These included a lack of skills, a lack of a suitable interface or information, that it was not part of a senior manager's role to use "Information Technology" and that senior managers tended to be older managers and older managers had difficulties with new technology. The first two reasons are essentially technical problems, we will concern ourselves with the latter two.

Several managers, both at senior and less senior levels, implied that it was somehow not part of a senior manager's role to use "Information Technology". Indeed for some senior managers it appeared to be almost a measure of their status that they could command human processing power, in the form of middle management or secretarial support, rather than have to use the technology themselves.

Perhaps the best example to draw upon to illustrate this latter point is to use the example of "The Manager as a Typist". The phrase "The Manager as a Typist" is used to encapsulate a belief held by many of the managers we interviewed. Examples of how this belief impacted upon managers' use of computer based systems occurred several times.

This notion was held by different people with different degrees of conviction although it was more prevalent among senior managers. In its least extreme manifestation it simply equated the use of a keyboard with "low level clerical tasks". Any manager "worth his salt" would always have something "more important" to do than to sit down, or be seen to sit down, at a keyboard. For example,

"... the secretary can get me something, why should I have to mess around with it?" (Regional Manager, Case D.)

In its most extreme form "The Manager as a Typist" equates the use of a keyboard with the use of a typewriter. Presenting such a manager with a keyboard is perceived by the manager as a devaluation of his worth to the organisation. For example,

"... I don't see any point in paying managers high salaries to sit at a keyboard. If I want information I can simply pick up the telephone or go direct to the person concerned." (Personnel Manager, Case E.)

The above example illustrates the problems that this type of a manager can cause for his colleagues. In a different company there was a manager who, although he found it quicker, easier and more effective to draft his letters on a word processor, had to close his door if he did because his boss had told him "he wasn't paying him to be a glorified typist".

Here the clear implication is that the belief that "computers turn managers into typists" may impact on the way the system is used. The macho view that "real managers don't use keyboards" may however also have longer term implications for the company. If there is the perception that managers who use keyboards are somehow inferior what will this mean for the sort of managers who are promoted to senior positions? If the managers who are promoted perpetuate this belief what will this mean for the long term prospects of the company that employs them?

The second reason put forward for the low use of Information Systems by senior managers is also an example of how a socially constructed doctrine might impact on the changes that take place during the implementation of a new systems. This example concerns the treatment of older managers. In our cases there was a widespread assumption that older managers would not be able to cope with the demands of the new technology. Where restructuring is taking place it was, almost without exception, the older managers who lost their jobs.

"... the official party line is that its people who are not seen as having a role. The general characteristic is that they're over 50." (Senior Personnel Manager, Case C.)

Older managers were widely seen as being less receptive to change and reluctant to adopt new working practices. For example,

"... some of the older personnel are very computer keyboard shy, they don't want to be involved. They just don't want or like them and they're afraid of them for some reason." (Accountant, Case D.)

Viewed superficially this might appear to be an impact of the system on the organisation. We would however identify two problems with this, both of which are illustrated by our case studies.

Firstly it is easy for the "problem of age" to become a self-fulfilling prophecy. It is expected that older employees will not cope with change or new technology and so they don't. Our case companies however provide a number of examples that suggest that older managers do not necessarily find learning new systems any more difficult than younger managers.

"... some of the younger people got very quickly into the keyboards, I think keyboards and computers are very much part of a younger persons

background. A lot of reservations from older people, but, in the end, we never had one failure (in the 250 people in his division) of people failing to come to terms with the system. I was astonished." (District Billing Manager, Case C.)

A recent survey of training by the Institute of Management²⁴ found that older managers received less training than younger ones, especially in larger organisations. It also found a widespread tendency to encourage older staff to take early retirement and an assumption that older staff were less motivated, less productive and therefore less likely to repay the investment in training. Other research²⁵ however has found little evidence to substantiate this view. It was clear from cases A and C in particular that older managers could be trained to use the new systems.

In our cases the belief that older managers can not cope with new technology appeared to provide what Zuboff called a "ritual justification" for making older managers redundant. If a firm is looking to reorganise the offer of early retirement may be attractive to both the company, as older employees are typically more expensive employees, and to the employees who can retire early with enhanced financial benefits. This approach however will become increasingly problematical. Between now and the year 2010 there will be a decline of 20% in the number of those aged between 20 and 30 in the UK and a corresponding increase in the number of 40 to 60 year olds'. Skill shortages are likely to be acute in companies where high levels of skill and knowledge are demanded. Short term gains need to be weighed against the long term pay-off of retraining an older manager and retaining valuable managerial knowledge and expertise within the company.

Both of the above examples show how a company's culture or ideology shaped the impact of the new information system. Case A however provided a number of other unique examples to illustrate the way in which culture can shape the system itself.

Case A is a medium sized company in the fine chemicals division of an American owned multinational. It employs approximately 600 people on two sites that produce chemicals for the pharmaceutical and agricultural industries. One site consists of a single plant that produces a single pharmaceutical product, the other contains the remaining three production units and produces a wide range of chemicals to order. The decision to introduce MRP II into the company was taken in 1989 however they had problems in persuading their parent company that the software that the parent company wanted was not suitable for their site.

"We were held back 18 months for political considerations ... It was the perception of the American company that they knew best what we should have on this site." (MIS Manager, Case A.)

He explained the Case A had the only 3 organic chemical plants in the group and that:

"... the others are pharmaceutical plants, and there is a big difference in the logistical operations of those places. Pharmaceuticals are much easier in terms of systems [the parent company] were applying their rationale that they'd put in on the pharmaceutical plants to our chemical side which was wholly unjustified." (MIS Manager, Case A.)

Eventually both the choice of software and the timetable for implementation was dictated centrally by the parent company. This was a source of some resentment, especially in the MIS department who saw their role change from suppliers of software to maintainers of somebody else's software. MIS had been in quite an influential position in the company and they now used this position to propagate their discontent with the choice of system throughout the organisation.

The influence of the parent company was not limited to the MIS department alone. Many of the senior managers in Case A were constantly making the point that the new MRP system required people to abandon the old way of doing things and to stick to the schedule produced by the system. A director explained that, in the past:

"All that mattered was getting the kilos out at the end of the day ... that is not the culture we have now. If it's not in the forecast, if it's not in the plan, we don't want it ... what we're saying now is ... if you've made what we've asked you to make stop. Do nothing." (Director of Logistics, Case A.)

This transition was obviously a difficult one to make for a number of reasons, some of which have been outlined above. The problem was exacerbated however by the culture of the parent company. One director confided:

"I don't think our lords and masters in America have yet made the mental jump because they still are using the old criteria for measuring performance, they still think the old way and its taking time to educate them." (Purchasing Director, Case A.)

An illustration of the way in which the attitude of the parent company disrupted the smooth functioning of the system that they themselves had chosen was provided by one manager who explained:

"... we've got a very demanding lady president, lady might be the wrong terminology, but we've got an American lady who basically runs the chemical group, and she has a habit of ringing up the MD to find out how we're doing against a particular order ..." (Master Scheduler, Case A.)

The result of the phone call is that the schedule is changed. The view from lower down the organisation is that "it's one law for them and one law for us".

"I don't think that the supervisors get the support from management, that they should do ... there are people who say MRP II is for you lot [but] they still react to the old way of running the company ... Yes, there are ... management pressures, but you shouldn't just say "Right I know this is MRP II but we're going to stop all this for a month because our boss over in the States [and] she wants these figures" ... they should be able to work within the system, rather than jumping out of it." (Planning Manager, Case A.)

In the first set of examples the features of the technology itself that shaped its impact. In the above examples existing culture and relationships played the dominant role in shaping the impact on the organisation. Finally we will consider some examples of how people's interaction, and reaction to change, can shape the impact on organisation over a period of time.

4.3. The Role of Interaction in Shaping Outcomes.

It is clear from the above examples that simple deterministic arguments that "technology shapes organisations" or "organisations shape technology" are inadequate to explain the richness and complexity of outcome when new Integrated Information Systems are introduced into an organisation. Although both effects play a part there remains an element that does not seem to fit into either model. What is the explanation for this?

Throughout the organisations in the research managers stressed that the use of these systems was only one part of their job.

"... if we're talking about managers then obviously the most important thing for a manager is how he manages the job, of which the computer aspect is a small, though important, part." (Customer Relations Manager, Case C.)

The information the systems provide may be useful, even essential for the manager's work but, in the end, managers see their use of the system as being of only marginal importance to their job as a whole.

"... its still only a tool to enable management to make a better decision. It gives you more information ... it saves a lot of legwork but at the end of the day all it says to you that's the information ... then its down to me personally to say well, do I really want to buy that, can I wait another month?" (Planning Manager, Case B.)

The essence of the way in which people use the systems is in how the information is used rather than how it is obtained. This is particularly the case for managers whose central role is to make decisions. The characteristics of the particular system may constrain certain choices, the dominant culture may constrain others, but there is usually plenty of scope between the two for managers to shape their own outcomes. Once this is accepted can be seen that simple deterministic models can never predict outcomes with absolute certainty.

If we accept that managers can, and do, exercise their "free will" is there evidence in our work to support this? The clearest indication of this was found in the different approaches taken by two managers in the same organisation, Case C. The first manager provided this example of how he used the system to monitor the work of his subordinates. In answer to the question "Does the system enable you to exercise more control over your subordinates?" he answered:

"Yes definitely ... From the highest to the lowest, yes ... what that means that is a very tight control on a level 1 manager. He's having to report to me weekly on the number of jobs he's done in that category and where they went wrong. Now in the past he couldn't have got that information so he's totally accountable for that result ... I'm in here at 7.05 and they're still in bed. This morning at 7.10 I knew how we'd done yesterday, and they know that I know, because, as soon as I see them, I say, what happened here?" (Repair Manager, Case C.)

The second manager, also a repairs manager in the same department of the same organisation, uses the same system but answered the question in a totally different way.

"I can actually see the work they're doing electronically ... the people that work under you aren't under pressure (because) the boss is sitting beside them ... so it tends to be a lot more truthful ... Having said that I do sit with them as well rather than being completely remote ... you could possibly do the whole job electronically but at the end of the day you've got to have personal interface with them, you know they're your people and you've got to be seen to be there with them." (Repair Manager, Case C.)

Taken in isolation the first might have been used as an example of the system impacting on the working practices of managers. The system provides information on people's work loads and working patterns automatically and so managers become divorced from day to day contact with the people they manage. Similarly the second example, taken in isolation, might have been used as an example of the culture of an organisation shapes the way that the system is used. The culture is one of "the personal touch" and so that is what happen even although a more "efficient" technology exists. Both however are examples drawn from the same organisation. Two individual managers use the same system but in entirely different ways. It was not the system, or the dominant culture of the organisation, that determined the impact but the choice made by the individual manager about how to use the information from the system.

The ability of managers to shape the impact of information technology plays a central role in the way in which the impact of the technology changes over time. Although the longest of the case studies only ran over a two year period it was clear that, even over this relatively short period, the impact a system can have may change considerably as groups or individuals reacted to changes in their circumstances. Again, Case A provided the best example to illustrate this point.

Case A measured production on the basis of production recovery. Every kilo of product recovers a certain amount of the company's overall costs. Some products have a higher recovery value than others. In the past production had been able to meet the end of month financial targets by altering the production schedule so that, if necessary, high recovery value products could be produced.

This had always seemed to be perfectly adequate, and on a monthly basis, between 90% and 105% of production costs were recovered. When MRP was introduced the same model was used by the production managers to estimate of how long, on average, the various processes would take. What quickly became apparent after MRP II was on line was that 70% of the processes were falling below these targets. The plan was being constantly altered and potential problems were deferred until next month. This was termed "The Bow Wave Effect".

A plan was produced in the first week of a month. By the end of the second week production management had looked at the plan and, with the consent of the planning department, altered parts of it they claimed were no longer feasible. This happened every month and part of one months plan was always carried forward into the next month. The manager in overall charge of implementing the system commented:

"We understood the mechanics of this bow wave effect and we thought we'd cracked it ... So what we decided to do, wrongly as it turned out, was to say, well, we have to say that the capacity in the plant is not as big as we think it is. So in any 30 day period we've got to expect to lose say 3 days through untoward events that are not modelled, so we should only plan for 27 days." (Head of Project, Case A.)

However all that happened was the plant managers looked at the new volumes, reduced them slightly, and then still did not achieve them. The conclusion that the senior managers reached was that:

"... plant managers are using this recovery figure as the target ... So all we've done by taking days out is we've given them a lower target." (Head of Project, Case A.)

This view was confirmed by the observations of the warehouse manager.

"It's an awful thing to say but I've just started to realise (that) production actually delay schedule one day but then during the night they'll come with a message to the warehouse 'can I have this material because I'm ahead of myself' ... They've delayed it the first day but they're bringing it back on-line the second day ... They're gradually getting to know how the system works and how they can help themselves." (Warehouse Manager, Case A.)

It is clear that the initial impact of the MRP system was to change the role of production dramatically. The old culture where "production was king" and they were "a law unto themselves" had, it seemed, been fundamentally changed. It would however be naive to think that such a cultural shift could be made overnight. A plausible explanation for the Bow Wave Effect would be that production were playing exactly the same "end of month hero" game that they played before.

The initial impact of the technology in case A was largely determined by the features of the new system. This impact was, to some extent, in conflict with the dominant culture of the organisation. Over a period of time the two interacted to shape a new outcome where certain features of "company one" began to reassert themselves. This new outcome was shaped both by features of the technology and features of the corporate culture but was mediated through the actions of individuals and groups of people with a common interest.

The impact of these systems is not a one off effect but something that evolves over what might be some considerable time. In Case A, for example, the first formal meeting to discuss MRP II and its application to the company took place in July 1987. The cut over to MRP II did not take place until September 1990. Similarly the amount time it took for these systems to "bed in" appears to have been completely unexpected. There were widespread and quite unrealistic expectations of the pace and duration of change. For example, fourteen months after cut over, and some five and a quarter years after the first formal meetings, the manager responsible for the implementation of MRP II in Case A commented:

"... I guess I naively thought that maybe within a year or so after putting it in we would have everything sorted. I think now we are probably talking about 2 to 3 years." (Head of Project, Case A.)

A senior manager in Company C made a similar observation. He commented that, once the new system had been introduced, many members of his staff felt that "that was that" and their work could "go back to normal". He observed that he did not have any problems with the initial introduction of the systems because:

"... staff are actually keen when they have got something new turning up. There is the worry of the new technology to get over, which is very hard, but at the same time they are receptive to change". (District Billing Manager, Case C.)

However once the new system was in place he began to find resentment whenever changes were needed to "fine tune" the system.

"... fine tuning in many ways becomes the most difficult because folk say 'hey, I'm happy with this, why do you have to change that' and 'huh more change!' ... its when you think you've succeeded that your real problems come in because the world doesn't stop, that was the hard part ... that's a far bigger problem." (District Billing Manager, Case C.)

Although these case studies could only provide snap shots of the developing impact of the introduction of these systems it was clear that the nature and direction of the impacts changed over time.

At one level this is simply stating the obvious. As we saw with Case A the system was three years in the discussion stage and it was expected to take at least three years to bed in. Over a period of six years it is only to be expected that there will be changes both in the technology and in the environment in which the company operates. For example in this time at least three different short lists of potential MRP systems were considered and the ownership of Case A, as well as its parent company, changed. In case G there were similarly dramatic changes at board level during the two years that their system had been in development. Change however also takes place in a more subtle and less obvious fashion.

When the new systems were first introduced there were a mixture of impacts some of which were expected and some of which were not. However, as the people who worked with the systems became familiar with them, they began to make decisions about how they, as individuals, might use the systems. In case A production managers who were no longer able to play the "end of month hero" game began to find ways of playing the old game but by new means. In case C there were examples of managers who found ways of disguising what was happening in their area from the superiors. The impact the systems had began to alter subtly. In some cases managers who had initially felt that using a keyboard was somehow inappropriate changed their minds. In others managers who initially felt that the systems had led to a loss of face to face contact found that in fact they had opened new channels of communication.

5. Summary and Conclusions.

This paper has examined a number of examples of how social processes shape, and are shaped by, the introduction of Integrated Information Systems. It has also illustrated the rich and complex nature of the interactions between such systems and their social

context. It provides several examples to illustrate the various forms of "impact" that occurred in our case study companies.

The first were essentially technologically determined impacts. The introduction of these systems was accompanied by a need to follow a set of more structured procedures. Thus, in one sense, a dimension of managerial freedom of action was constrained. In most cases there was also a conscious decision to use the information provided by the systems to shift responsibility and accountability down the organisational hierarchy. The former effect was clearly a technologically determined impact on the work of managers. Viewed as an outsider it would appear to constitute a classic case of deskilling. However, as we saw later, managers saw using the information produced by the systems as being the essence of their work rather than the operations they performed with the systems themselves. Although, strictly speaking, the requirement to follow a more proscribed routine when using the particular system is a technologically determined impact it was, in reality, only minor.

The major, and more immediate, impact was caused by the ability of these systems to distribute information: a central pillar of managerial work. In contrast to what might have been expected from a review of the literature on the subject the impact was felt most acutely horizontally rather than vertically. The system did not accentuate vertical differentiation but exacerbated existing horizontal stresses. Companies A and G provided particularly clear examples to illustrate this effect. In both cases the visibility brought about by the new systems impacted directly upon the informal authority of a traditionally powerful group in the company. The data stored and communicated by the systems was used by managers, and others, to create a new view of the organisation that was in conflict with the old.

The second set of examples concerned culturally determined impacts. In one sense these provide a counter argument to the first by suggesting that existing culture shapes the impact of the new technology - regardless of the technology. It was clear from the two main examples that the low use made of these systems by senior managers had a cultural as well as a technical dimension. The actions of these managers ran counter to many of their expressed intentions. Several senior managers had, either explicitly or implicitly, expressed the belief that these new systems would facilitate de-layering and enable a redistribution of responsibility and accountability. However, by shunning the use of the technology themselves, and by continuing to rely upon juniors to collect and collate information for them, their actions mitigated any of the desired effects the systems might have had in this area.

Preconceived notions of the abilities and motivations of older managers provided one justification for their stance but viewed more generally it also provided an example of how socially constructed doctrines shape the impact of systems. The result of the introduction of the systems in several of the case study companies was felt most acutely among the older members of the organisation. This however was not a feature of the system but a result of the expressed belief that older managers can not cope with new technology. In companies where, for one reason or another, older managers were not shown the door it was found that most older managers could be trained to use the new systems.

The role of the existing culture in shaping the impact of the new system was not however limited to the shared ideology of a particular group at a particular site. Case A provides a striking example of how the dominant culture of a parent company can shape the nature of an impact at one of its divisions. The choice of the system is perhaps a trivial example but the effect it had for the MIS department of case A had more long term and serious repercussions. A more subtle effect was the way in which the senior management of case A reacted to perpetuation of the old style of management in the parent company. Again this provides an example of how, if an organisation's culture and management demand the perpetuation of a particular style of working, then that is what tends to happen.

Finally we also saw examples to illustrate how the actions and interactions of individuals and groups can also shape the impact of systems. In many ways this is the most problematical of impacts. With a sophisticated understanding of the capabilities of systems, and a deep enough insight into the dominant culture of a company, many of the first two classes of impact might have been foreseen and planned for. The ways in which individuals or groups choose to react to change however are less predictable. It must be expected that, at an individual or group level, the impact of these systems will alter with time even in the unlikely event that the capabilities of the technology, the organisation's environment and the overall company culture do not change significantly.

This is particularly the case with managers and Information Systems. Information is, by its very nature, malleable and a political resource. Similarly managers tend to be both political animals and used to making choices based of the information that is available to them. It must be expected that a meeting of the two will carry some degree of uncertainty as to the outcome and may change over time. We have seen that the data held and transmitted by these systems has the potential to disrupt existing relationships. What should not be forgotten in this context is that managers themselves play some part in deciding what data is collected and in what ways it will be stored. For example in Case A the decision to continue to calculate and record recovery rates, even although these were now of far less importance as a metric for production, was a decision taken by the management team in Case A.

Similarly it must be remembered that integrated information systems take time to develop into maturity, if indeed they ever do reach a stable and mature system. Case C provides a very good example of a system that has continued to evolve and grow over a considerable period and shows little sign of stopping. Like the potential for such systems to play a role in the creation of inter-functional conflicts, the dynamic nature of their impacts is a point that is often overlooked. Traditional approaches to a system life cycle assume a straight forward linear development that takes little account of the possibility of false starts or reversals of policy.

The authors believe that this paper has demonstrated the validity of adopting a less rigidly deterministic approach to the analysis of the impact of Information Systems. It has clearly demonstrated that the effects such systems have are both complex and dynamic. It argues that use of static deterministic models will inevitably lead to a misleading and oversimplified view of the relationship between an Information System and its social context.

In conclusion the authors offer the following observations as general guidelines for those charged with the task of implementing an Integrated Information System.

Firstly it is important to recognise that cultural change, as well as changes in technology and organisation structure must, where ever possible, be planned for and managed. The possible political implications of such change must be anticipated and addressed explicitly, not ignored or underestimated. It is important to recognise that conflict may be an unavoidable part of introducing such systems. Learning to live with this and manage it may therefore be necessary.

Secondly it is important to establish realistic expectations for change. In particular to recognise that change is a long drawn out and uncertain process that may take place over several years. It is important to recognise that not all of the potential changes can be predicted beforehand. Any plans for implementation should be cognisant of both the time scales and the degree of uncertainty involved with such systems. Don't underestimate the extent of the organisational change that may take place and don't expect too little, or too much, too soon.

The above are offered as general guidelines based on findings common to every case study company in this research. The following observations are more specific and are based upon observations that, although common, are less obviously universal.

The problem of uninvolved senior management must be tackled if it arises. The attitude that the use of new technology is less relevant for senior management should be questioned. At the same time the broader organisational goals and the particular needs of senior managers need to be carefully considered at the systems design stage.

Examine assumptions about age carefully. It is easy for the "problem" of age to operate as a self-fulfilling prophecy. Older employees may be expected not to cope with change and new technology and so they do not. Valuable skills and experience could be lost in this way through what might amount to little more than an "administrative convenience".

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