Automating managers: The implications of information technology for managers in five manufacturing companies

Thesis

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AUTOMATING MANAGERS

THE IMPLICATIONS OF INFORMATION TECHNOLOGY

FOR

MANAGERS IN FIVE MANUFACTURING COMPANIES

TWO VOLUMES
VOLUME 2

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OPEN UNIVERSITY

June 1987
1. **THE COMPANY** : Medium-scale, designing, manufacturing and marketing of women's outerwear; U.K. national.

1.1 **History**

In the years before the first World War, two Polish emigrant brothers were making up garments for other wholesale manufacturers in London, and gained a reputation for good workmanship and reliability. In 1912, one opened a small retail shop, while the other formed the company that still bears the original name. Following army uniform contracts during the war, the brothers came together again, and in 1924 became a private limited company.

By the 1930's the company, though still acting as subcontractors, broke with the tradition in small tailoring establishments, by selling direct to retail shops. Showrooms were opened in the West End, agencies established in Leeds, Dublin, Glasgow and Belfast, and in 1936 the company became public (incidentally - the issue was oversubscribed twenty-two times). Under the Government's dispersal programme, in 1939, the company took over its present premises in 'Southtown' - a factory that has remained the largest in the group. A highly successful brandname (label) was launched in 1951, shops-within-shops began in the early 1960's - another break with tradition, and in 1982 a completely new venture with garments made in the Far East has been extremely successful. Currently the company has five major factories totalling over 300,000 square feet, producing 60,000 garments a week. Turnover statistics are shown in Figure 4.13.
### Employees, Turnover, Profit

<table>
<thead>
<tr>
<th>Year</th>
<th>Employees</th>
<th>Turnover Profit £'000</th>
<th>Trading Turnover before tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>1968</td>
<td>3775</td>
<td>10104</td>
<td>737</td>
</tr>
<tr>
<td>1969</td>
<td>3782</td>
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<td>712</td>
</tr>
<tr>
<td>1970</td>
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<tr>
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<td>18246</td>
<td>1801</td>
</tr>
<tr>
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<td>3109</td>
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<tr>
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<tr>
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<td>28546</td>
<td>926</td>
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<tr>
<td>1978</td>
<td>4418</td>
<td>30594</td>
<td>1225</td>
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<td>35686</td>
<td>1824</td>
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<tr>
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<td>3360</td>
<td>39721</td>
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</tr>
<tr>
<td>1983</td>
<td>3272</td>
<td>40884</td>
<td>1026</td>
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<td>3229</td>
<td>47939</td>
<td>2340</td>
</tr>
<tr>
<td>1985</td>
<td>3521</td>
<td>64046</td>
<td>3553</td>
</tr>
</tbody>
</table>

* Highest

### Products

'Fashion' produces ranges of women's outer clothes (and since 1985, men's sportswear), designed for specific markets, and sold under several labels. The quality and style of each range is targeted on a sector of the market – for instance for distribution through chain and multiple retailers (such as British Home Stores, C & A, and Littlewoods). Each manufacturing plant produces a distinct portion of the range, and at 'Southtown' all the clothes are for two brands, catering for the upper-middle market. These ranges are sold via multiple stores, usually through shops-within-shops, of which there are around 400, and there is also a minor but increasing export business.
1.3 Organization

The several functions of the company are split between seven sites:

1. Headquarters (London)
   Finance
   Design
   Fabric purchase
2. Warehouse ('Westholt')
   Distribution
   Main office of two 'brands'; Computer Centre for H.Q. and 'Westholt'
3. 'Southtown' Factory (including Personnel and Production functions for 'Southtown' and 'St. Davids')
4. 'St. Davids' Factory (including Computer Centre for 'Southtown' and 'St. Davids')
5, 6, 7 Other factory sites, not studied

(Note: 'St. Davids' site was closed in 1986).

Official organization charts were not furnished by any manager, indeed patterns of responsibility and communication appeared not to be charted or written in any available form. Managers seemed to have 'spheres of influence' rather than definite responsibilities. The organization in Figure 4.14 is therefore an approximation.

Because of the informality and loose definition of responsibilities and reporting patterns, it was impossible to categorise managers in terms of specific hierarchical levels. Managers appeared themselves to have difficulty in locating their 'tier' positions, and there was often discrepancy between a manager's stated tier position, his title, and the perceptions of that role by other managers. The structure was inherently 'flat' with only about three levels between the chairman and shop floor section-foremen. (See Figure 4.14).
Figure 4.14

Organization

CHAIRMAN*

MAIN BOARD

H.Q.
Design & Finance

Administrative
Director
(Warehouse &
Distribution)
'Westholt'

Computer*
Manager
('Southtown')

Computer*
Manager
('Westholt'
& H.Q.)

Warehouse &
Distribution**
Managers

Other
factories

Brand
Directors

Brand**
General
 Managers

M.D. ('Southtown')*

Personnel*
Director

Maintenance
Manager

General*
Manager

Production*
Co-ordinator

8 Manufacturing*
Managers

1 to 3 Supervisors
to each Manager

Tier 1 (Chairman) 1 Interviews
2 3
3 5
4 4

13

- 160 -
1.4 The Study

Thirteen interviews were conducted at the 'Southtown' site, the 'St. Davids' Computer Centre, and at 'Westholt' central warehouse: questionnaires were returned from these sites and from H.Q. managers.

1.5 Summary

'Fashion' is therefore a loose federation of manufacturing plants, centrally co-ordinated, producing and distributing women's clothes. A British company, with 3,300 employees and a turnover of £48 million in 1984, 'Fashion' has paid a dividend every year since 1936. Production is primarily based on skilled manual labour and apart from the two independent computer units set up ten years earlier, I.T. is not in evidence. There is no automation, robotics, and only one personal computer.

The company was thus at an early stage of applying I.T. systems to a diffuse, low technology, low definition organization.

2. I.T. IMPLEMENTATION

2.1 I.T. Culture

In every area discussed with managers three norms soon came out: firstly, the emphasis on day-to-day, and even hour-to-hour, operational tactics; secondly, the looseness of responsibilities and reporting patterns, amounting to uncertainty in several instances, and thirdly, the optimistic, and deeply engrained acceptance of the current, apparently successful way of doing things.

Labour intensity in garment manufacture remains high, and at the two factories visited 'traditional' sewing predominated accomplished skilfully and flexibly by women. Each garment requires many operations - cutting, sewing buttons, pleats, pockets,
collars and pressing. Throughout, the production process used low-technology, with no automation or robotics, though movement of semi-finished and finished garments between sewing stations was by conveyor. Each operation had a work-study-fixed number of work-minutes used for piece work payment and in costing and planning. It was in this field that computers were focussed, as it was seen by managers as the core of the production operation.

London H.Q. assigned designs and quantities to the factories (about 10,000 garments each week at 'Southtown'), but these were adjusted as the season moved on by 'Westholt' on the basis of their computer analysis of sales in shops. 'Westholt' is the central warehousing and distribution facility, receiving all factory production except knitwear, storing, organizing and despatching some 40,000 garments a week. Operations on the warehouse floor were entirely manual by unskilled and semi-skilled workers.

A Director (F-8) explained that their 'labels' had strong acceptance in the market-place, and that within each label, there would be hundreds of individual garments, varying in style, fabric, pattern and colour. Not all would be successful in any season, but even the failure of one or two lines was insignificant - and complete failure was unknown. Someone always bought most of the clothes - though at the season's end, prices would be marked down in the shops. There was a generalised confidence in the strengths of brand names in guaranteeing sales success. Once the season's ranges were ordered (several months ahead) the company was relatively certain of its financial position for the next six or seven months, and this secure optimism rang through all the interviews.

The emphasis on "getting the garments through the door" was paramount, to the extent that long term planning seemed foreign to most of the managers. "In the fashion industry products are always changing and this needs flexibility. We have no strategy for anything, including new technology". (F-2, Director).
"There is a company policy to maximise the throughput of manufacturing units, and to merchandise without financial loss - but no real strategy". (F-8, Director). All attention was focussed on two matters: getting this season's models into the shops, and having the right models for next season, though "there is little market research - it is intensely personal, based on a detailed grasp of the market place - a frenetic business", according to F-5 (Director).

As will be seen this kind of approach applied also to I.T.

After the initial decisions to purchase the two computers (one in 1974 and one in 1978), in both cases the subsequent development of systems has been primarily in the hands of the computer centre managers. No evidence of a company plan for I.T., or even a consensus amongst the interviewed managers, could be found. Each manager had his own views about computing and systems, but there was an absence of any co-ordinated effort at studying or analysing the overall need, or in devising some plan for I.T.

2.2 I.T. Applications

The first computer (IBM 370-125) purchased in 1975 was for three years applied more or less exclusively on retail sales and stock recording, a complex, repetitive and labour intensive process. Using 75% on line, and 25% batch entry, and with 25 people in data processing operations (eight input VDU's), this phase was a "translation of the manual system, over-burdened by volume, into a computer image of it", (F-7). In 1978 the computer was upgraded (to IBM 370-138) and in the following two years the "introduction of professional systems analysts making a positive attempt to meet business requirements", (F-7). Most effort was in order processing, sales ledger and retail stock replenishment, with the innovation being almost entirely within the Data Processing department. The D.P. team increased to 27, and VDU's to 20, the system being 90% on line. Production recording started in 1981, with a new upgrading to IBM 4341-1, now 100% on
line, with 30 VDU's, ten of which were remote from the D.P. department. A payroll package was also introduced.

By 1983 a 4th generation programming language was being used and more sophisticated data base management using 100% on-line entry on 40 VDU's, twelve of which were remote, with 32 staff. The main focus continued to be retail management reporting (based on order processing and stock systems) and on production reporting. Almost all this was at 'Westholt' and linked to the warehousing and distribution functions there, though with ten remote terminals at the London H.Q.

The main use of this computer had therefore been:

- Retail sales and stock recording;
- Order processing and stock distribution;
- Payroll;
- Production control - in a minor way.

All 'low intelligence, high volume' tasks, of 'transaction processing' type.

The computer manager was well informed professionally with, for 'Fashion', an uniquely wide experience in other companies. Almost all the I.T. applications had been initiated within the D.P. department, and against a background of indifference amongst most managers, and often outright scepticism and opposition, at junior and senior levels. "I have spent the last five years trying to persuade the senior management of the advantages of computing, but have not really succeeded - though there has been some mellowing ... The nature of the company is more important than the state of the art. My analysts have great difficulty in convincing managers of the need for structures - everyone is so busy on day-to-day affairs - the problem is how to change the company system. I am not briefed on company business strategy, and there is certainly no long term plan for I.T. - except for our department to pick off parts that are worth computerising - I am more an 'organization and methods' man". (F-7).

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Meanwhile at 'Southtown' a wages clerk, with the help of the company secretary, learned programming, and together they built up the existing computer unit. In 1978 a Hewlett Packard 9830, using punched card entry was introduced for payroll, stock control, invoicing, and produced management reports on stock, and profit/loss. This was 100% batch entry. An HP 250 mini-computer was installed in 1980 with 100% on-line operation, using six VDU's; two remote. Payroll, stock control, purchase ledger and invoicing were all on this machine, but the main work was in the production issues - piece work, work-in-progress, operator earnings, and price listings for garment styles. Eight computer operators were involved, plus two managers/analysts, though everyone seemed to be involved in other work as well.

The development initially entirely depended on the computer centre, but had the goodwill of the company Chairman, who the two managers met, or talked with by 'phone, every month or so. "The policy was to superimpose computer systems on the existing work arrangements, to save on head-count, and speed up the data flow. Applications were decided on the basis of 'what we knew best' and could get a 'reasonable program together, getting rid of 'drudgery' jobs'. (F-4). During this period of three to four years, there was little support from managers or supervisors in the factory, but gradually the two local Directors began to be favourable to the development. In 1985 a young (30), and well qualified, production co-ordinator, with management experience in the rag trade, was transferred from the London H.Q. to 'Southtown'. He was obviously aware of the potential of new systems for management, and had become extensively involved in computing.

"I was pretty against computing at first, because of the dangers of over-sophistication in equipment and fears of break-downs, but since being at 'Southtown' I am very impressed. But getting anything done here is like pushing a steam-roller uphill. The biggest problem has been to get information ... the average age of our managers is 45-50 and they are untrained in the use of I.T., and reluctant to get involved ... Systems are increasing
but action based on systems is not keeping pace". (F-1).
(Note: after a year in this role he was moved back to London).

So both at 'Westholt', and at 'Southtown', a handful of energetic enthusiasts for I.T. had been slowly introducing computer systems, overlaying the existing P.M.M. arrangements.

2.2.1 Finance

There were nine accounting/finance departments in the group dealing with disparate activities, and there was no intention to centralize, or to design common I.T.-based finance packages because of the differences. In fact various financial print-outs were available in some sections of the company, but no emphasis had been placed on computerised accounting.

F-12 (label manager): "The hardware is available and there is time on the computer, but there had been no focus on finance. Our accounting systems are awful but the computer manager is not keen to systematise one label ... and the other labels are not pressing ... and no-one really senior watches the overall I.T. situation". An administrative Director (F-9) thought there was insufficient user-orientation: "The initiatives are coming entirely from the D.P. department - but the users lack I.T. experience, can't see the potential of the technology, therefore take no systems initiatives".

2.2.2 Warehousing and Distribution

Forty thousand garments were moving into and out of the 'Westholt' warehouse to 600 outlets each week: it was this area which had received most systems attention. With computerisation, time to allocate garments had reduced from six weeks to eight working days, with a reduction (of 60) from 70 to 10 clerical staff, in spite of a more than doubling in garment-throughput in five years. The manager (F-9) in charge had been involved in the systems design and was well pleased with its operation - the whole process of advice of goods
received from factories, orders placed by customers, deliveries required, and mode, was now entirely computer based. (Much of this can be considered HEAD level 3 work: operational planning, decisions and control). F-9 spent about an hour a day on his terminal, and perhaps an hour working on masses of computer print-outs. Situated in an 'open' space in the middle of a huge, entirely manually-operated warehouse, here was a manager heavily involved in computer operation (of the 'intelligence system'). The physical work within his responsibility, the warehousing, was entirely manual.

Because of the predominance of short runs, and the changes in runs, both the result of responding to H.Q. and 'Westholt's instructions, the production planning was immensely, and frustratingly, difficult. While some of the computer print-outs evidently had utility to floor managers, they expressed scepticism of the I.T. system. F-11, for instance, explained that while the daily report on location of each garment in the factory was useful for machine loading planning, most of his decisions were based on his minute-by-minute direct intimacy with the factory operations, and his own tailoring skills.

Most of the floor managers had tailoring backgrounds, and many (up to 25) years of relatively little change of procedures, neither had they had any training in 'systems'. Generally they accepted the utility of some computer-produced data, but there were many knowing smiles about the computer system.

2.2.3 Other Functions

There were no I.T. applications in Personnel, Design, or in the control of production machines.

Thus in this company computers were at an early stage of development, with no integration between systems.
'Fashion' was based upon traditional, low technology skills and practices established over decades, managed by people with a long experience of the company, and usually on the same site and in the same job.

Amongst the interviewed group, the average length of service was 15 years. Factory managers had tailoring backgrounds, had moved up from the shop floor, and were exclusively men. The two warehouse and distribution managers had been in basically the same job for more than twenty years. The I.T. managers, personnel executive, and general brand managers had much less experience of 'Fashion' (averaging seven years) and more experience in other companies than the other managers.

3.1 Involvement of Managers in I.T.

Of the managers interviewed three were I.T. specialists, four were 'involved' with I.T. and six were only slightly implicated with I.T. The distribution by function is shown in Figure 4.15.

Figure 4.15 a. I.T. Involvement of Managers

<table>
<thead>
<tr>
<th>Function</th>
<th>A</th>
<th>B/C</th>
<th>D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finance</td>
<td>2</td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Warehousing/Distribution</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Production/Factory</td>
<td>2</td>
<td>2</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Data Processing</td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>13</td>
</tr>
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</table>
b. Pattern of I.T. Involvement by Tier

<table>
<thead>
<tr>
<th>Tier</th>
<th>A</th>
<th>B/C</th>
<th>D</th>
<th>Total</th>
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</thead>
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<td>3</td>
<td>3</td>
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<td>2</td>
<td>6</td>
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<td>Tier 4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>13</td>
</tr>
</tbody>
</table>

c. Involvement in I.T. Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>A</th>
<th>B/C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has VDU in own office: per manager</td>
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<td>1.0</td>
<td>.2</td>
</tr>
<tr>
<td>Has PC in own office: per manager</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of packages used/daily</td>
<td>0</td>
<td>.6</td>
<td>.6</td>
</tr>
<tr>
<td>Hours/week on systems issues</td>
<td>10</td>
<td>2.8</td>
<td>.9</td>
</tr>
<tr>
<td>Minutes/day on terminal or PC</td>
<td>5</td>
<td>64</td>
<td>6</td>
</tr>
<tr>
<td>Electronic messages sent/day</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

In every case the managers studied regarded I.T. as an increasing element in their roles, though current time on this element and its rate of change was unique to each manager. Virtually all the managers claimed much more involvement with systems and computers and more knowledge of this field than five years previously. The extent of claimed increased involvement and knowledge of I.T. corresponded well with the current actual use of terminals and implication in systems design and modifications.

Most of the I.T. applications were directed at operational level (piece work control, production control, and distribution and stock control), and the major impact on managers was at middle management level. At the upper levels there was slight direct effect: "I.T. has not made any difference at all to me - the only benefit is that people are better informed. Managers
reporting to me are more numerate - 'people orientated' managers may be decreasing, and 'data orientated' managers may be increasing". (F-5, Director).

Another Director, F-2, not obviously using I.T., felt that in some way or other the technology had effects on 20% of his role. This was not so much directly - I.T. involvement was unchanged - but in "considerations related to planning, training, shortages of skilled labour and efficiency of labour use". (F-2). He thought the biggest recent change in the company had been in the introduction of the 'standard minute' system on the shop floor and the associated computer analyses. "The greater availability of up-to-date information on costs, employee earnings and performances, and stock holdings, and the use of video to monitor and record working methods, are changing my emphasis".

A third Director (F-6), spending thirty minutes a day using his office VDU, felt I.T. was influencing his role by being "able to plan production targets with greater accuracy using stored computer data, and being able to pin-point areas of operator inefficiency". Although in no way a computer enthusiast, he said his involvement and knowledge of that area was increasing. Information issues were considerably more important than five years previously, and because of the computer, the usefulness of printed information was 20% improved. Another Director, responsible for finance and administration, with good general knowledge of systems, felt I.T. was not having much effect on his job. It was noticeable that while he claimed information issues (amount of paperwork, involvement with data gathering and analysis) had increased, his time on chasing information had decreased, as had difficulties in understanding data. He was using a personal microcomputer for specific issues like pension records, sales commissions, profit share scheme.

In all four cases these Directors at first commented that I.T. was having only marginal influences on their roles, but deeper reflection on their activities pointed to greater reliance on computer produced information, and an overall change in their
The role of the production coordinator was now entirely bound up with the computer system, in both day-to-day operation and in spreading its utility into other fields. Recently he had spent two weeks assisting in putting in a similar system at another 'Fashion' factory. He was interrogating the data base on-line many times a day, and constantly interpreting VDU and print-out data, to the factory manager and to the M.D. Before his job was created the production co-ordination had been a looser, less disciplined set of agreements between the M.D., and the floor manager. The computer, plus an energetic and informed co-ordinator, was gradually, and slowly, increasing the 'tightness' of the whole production management scene in spite of the existing traditional culture. One effect of this deeper involvement in systems was a change in relative power: "People involved in DP have more access to data, and data processes, and are gaining in power. To solve problems you must exchange data - and the data implies understanding the system". (F-1).

Similarly at factory manager, and floor manager level, whilst the bulk of management activities were continuing more or less as previously, the output from the computer, and the greater visibility of productivity and cost factors to the M.D., and the Production Co-ordinator, were changing the focus of middle managers. Problem areas were identified, and production amendments initiated, earlier - the organizational transparency was increasing.

For most managers at 'Fashion' then, the organizational setting was loose in terms of structure and definition of responsibility, but 'ways of doing things' were long-established, resistant to the changes inherent in computerisation. But data and
systems issues were slowly gaining in priority.

3.2 Pace

The numbers of managers in the three categories A, B/C and D were small, and therefore reported characteristics are treated with care. However, it was noticeable that B/C managers felt pace, and role routines had remained about the same, and time for reflection had increased, whilst D managers claimed pace and routines up, and reflection time similar to previously. It was true that the throughput of garments had increased substantially over the previous two or three years, so claims of increased pace of activities would be expected, and would perhaps be expected most in management roles not being much assisted by the computer.

Computerisation seemed to be tightening the routines of managers, not involved in I.T., and loosening routines for managers who were involved, allowing more time for reflection. "Everything used to be by hand, with much pencil work. To deal with a single rail of garments used to take hours. Now it takes a fifth of the time. I use my terminal all the time to check orders, and garments in stock, and switch deliveries between customers. I.T. has made life much easier" (F-9). He went on to explain that he now had more time for a deeper level of problem solving, rather than 'trouble shooting'.

The traditional culture at 'Fashion' probably allowed 'slack resources' in GALBRAITH's (1973) terms to exist widely. Management jobs such as production scheduling in the factory, and stock assignment in the warehouse, had been the responsibilities of operational managers, who, with P.M.M. systems, used their initiative and considerable skill, to alter tasks continually in coping with varying demands of output. And these, largely tacit management skills, worked, probably because of the existence of slack resources. Even with the relatively low level of computerisation, scheduling has become tighter, and a greater degree of forward thinking and planning...
is possible. Slack resources (i.e. staff and machines) are either becoming redundant, or are being used to increase throughput. However, tight resources (and scheduling) are contrary to the historical nature of 'Fashion's culture and call for more attention to planning and analysis.

3.3 Fragmentation

All managers studied had highly fragmented jobs, constantly being interrupted by telephone calls, and issues of the moment. There was no evidence that I.T. was changing this character.

At operational (and probably all) levels of management, proactivity has been widespread, and necessary. Increased computerisation is probably requiring a higher level of adherence to schedules and reducing the extent of proactivity on scheduling issues by low level managers.

This is an example of changed level of decision making. The traditional, fluid, ongoing series of adjustments to the production schedule initiated by floor managers on cues from information from H.Q. and 'Westholt', are being replaced by the tighter, more systematic computer schedules. The transition factor again is in evidence: these early, computer-produced schedules were inherently rigid - partly because of infrequent updates and partly because outputs were in hard copy. (From evidence in the more 'advanced' companies, as updating frequency increases, and line operation via VDU's replaces printed copy, a 'smoothing' of procedures is apparent).

3.4 Boundaries

The general looseness of definition of roles and responsibilities implies 'soft' functional boundaries. Managers tend to have 'spheres of influence' rather than areas of command. However, each site operates as a more-or-less self-contained entity, and managers often expressed criticism of other sites. Loyalty is firmly based on 'site' rather than on
function: few managers know what happens at other sites. For instance, "Garment designers (in London H.Q.) are distant from factory production - they don't consider the production engineering of garments - we do it here" (F-11). "We have a problem getting information on size of runs from London H.Q. - their excuse is they are considering buying items abroad". (F-3). "There has been a history of poor communication between H.Q. and 'Southtown', and marketing and distribution (at 'Westholt')". (F-1). "Biggest problem is the delivery of garments from the factories - parts come at different times - the factory is too rigid". (F-10 in Distribution). "Quality has been checked in the factory - but that's no good to us - we check it again in the warehouse". (F-9). "London H.Q. is the most uncooperative office I have ever known". Manager at 'Westholt').

The two computer centres (at 'Westholt' and at 'St. Davids') had no interaction - each proceeded entirely separately. In fact, the 'St. Davids' operation was regarded as "useful amateurism - no professionalism". (F-7 at 'Westholt').

Nevertheless, there was evidence that some integration was beginning to emerge. It appears that as managers are becoming more knowledgeable about data handling, and analysis, the potential of I.T. systems for addressing the longstanding and accepted scheduling problems in production, and distribution, and the issue of co-ordination between these two functions, is surfacing within the management group. What had for decades been accepted as the extant milieu of the rag trade, is being redefined as a solvable problem. Co-ordination is possible; slack resources can be reduced. "The operational aspects of our (brand) have been too separate from the computer centre - our sales targets are done by hand. Most of the data is actually on computer print-outs, but they are unreliable - yet. This is a fundamental flaw in the system. All the sales analysis and targeting could and should be done by the computer. I could save one person in each of our shops - maybe hundreds of people". (F-12).
3.5 Planning

Managers felt the time on which they focussed ahead was longer than five years ago, that planning elements in their roles were larger, and that longer term issues were given more attention. Although some of these comments might have been wishful thinking, it did appear that the traditional and frenetic activity of managers at 'Fashion' was yielding somewhat to the increasing disciplines of computer systems.

3.6 Summary

'Fashion' is in the 'rag' trade and many of its practices are strongly traditional, on the shop floor and in management. As yet there are few computer applications in place and these are at operational levels. The company is then in the very early stages of applying new technology.

Nevertheless managers are being affected. Data and systems issues are gaining in priority over previous 'social' management for middle and junior managers. I.T., as has been found in 'Engineering' and 'Hardwear', tightens operating routines, reduces detailed administration, and loosens the specificity of managers' work. But because 'Fashion' is at an early point in computerisation there is conflict amongst managers as they attempt to accommodate the tightening data disciplines (in their terms 'rigidity'), in an environment where looseness of role and procedure have previously been effective.

Increasing organizational transparency, be it in few examples, is also evident here. And as found elsewhere, the awareness of automatic and fast monitoring by senior managers, much concentrates the minds of factory managers.
4. MANAGERS AND PEOPLE

4.1 Numbers of People

At 'Souhtown' and 'St. Davids' factories total staff had reduced from 750 to 565 over five years while the output remained the same. (Note: 'St. Davids' factory was closed in the summer of 1986). These reductions were almost entirely from the shop-floor though some were clerical. At the 'Westholt' warehouse, a launch of a new and successful label, had substantially increased throughput of garments, and required new deployment of existing staff. Thus, although three-quarters of interviewed managers reported staff reductions in their areas, it was not possible to directly link I.T. with staff reductions. (This was in common with the other companies). However, there was little doubt amongst managers that I.T. had already begun to cause such reductions.

4.2 Skills of People

As mentioned earlier, 'Fashion' has a flat hierarchy - a low, wide pyramid with large numbers of manually skilled people - mostly women - on the sewing-machines and unskilled manual workers in the warehouse. No automation has been introduced in the factories, managers said, because of the difficulties intrinsic to manipulating cloth. Thus sewing and associated skills have been untouched by I.T. so far. Managers believed traditional sewing skills were fading away as older women left, but younger girls were "more flexible - more able to cope with a range of sewing jobs". (F-3). Although 'Fashion' had little tradition of formal training at any level operator training was increasing at 'Souhtown' to compensate for the retirement of older women.

Computer operation was impinging on office and management practices in warehouse and distribution control, factory production control, and piece-work payment procedures. From observation the few people engaged in these systems are using
distinctly different skills. It was particularly noticeable that clerical staff involved in computing were less wedded to traditional practices, and were often advising their managers about data and systems issues.

4.3 Management of People

Factory managers historically had been recruited for their tailoring and production expertise and for their ability to supervise operatives within the informal, traditional, and low-technology environment. At 'Southtown', managers quite obviously knew their operatives well, including "births, deaths and marriages" of their families. This familial atmosphere was also apparent between the managers. Each morning all the floor managers, and often the Personnel Director, and M.D. 'breakfasted' together. The conversation ranging over issues of cloth, production, payments, delays, absenteeism, - the stuff of their daily round.

Because of the incentive system, based on individual jobs completed, motivation of operatives was plainly high. There was a contented atmosphere. The managers spent a great deal of their time actually on the shop floor (and this applied also to middle management) in detailed contact with the issues of quality, production and labour, - as F-3 said: "trouble shooting and keeping the shop floor happy". There had been no strike for 36 years, he claimed.

While the 'Westholt' warehouse was patently different in terms of work content managers there also appeared to have relaxed, informal relationships with subordinates and peers.

No managers spontaneously talked of training or of 'development' of managers of supervisors. There appeared to be a tacit and widespread assumption that training for themselves was not required - that the ongoing arrangements were the 'natural order'. In the situation of slow rate of change over many years, the only apparent training need was for operatives to be

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brought up to skilled performance as rapidly as possible. The Personnel Director was well aware of the general lack of training, and policy for training, but previous M.D.'s had been unsympathetic to these needs, and little had transpired.

Thus, the essential character of people management in 'Fashion' based on decades of similar experience, continued, - a flat management structure, with the bulk of staff being shop-floor operatives, and managers in a close and friendly relationship with staff. No high technology was in use on the shop floor, and only a dozen VDU's were located outside the computer centres. In essence, then, the style of management (in relation to people) seemed not to have been much affected by I.T. The slowly encroaching computer system was requiring managers to focus more on statistical information, and that meant an hour or two engrossed in print-outs, or interrogating a VDU, and in turn, that implied less time actually on the long-established conventional roles. Further, there were early signs that systematisation of scheduling was having effects on the highly decentralised authority held by managers to deal proactively with day-to-day events. It was this authority which underpinned the status of the managers in the context of a low technology, loose definition of responsibility, milieu - particularly in relation to employees on the shop, and warehouse, floors.

Although at an early stage, increasing systematisation of production planning, and a tighter co-ordination between functions, and between sites, was weakening the current 'tribal chief' role of floor managers - and there was some evidence that intuitively they may understand this already.

4.4 Summary

Computerisation has only been applied to a few areas of the business but managers felt it was already reducing labour. Probably this derives from the tightening of systems. Clerical staff in computerised sections certainly appeared to be less wedded to established conventions. The style of people-manage-
ment had been little changed by I.T., though managers undoubtedly were having to give more attention and time to computer data, and that meant less time to the more familiar arena of people.

5. MANAGERS AND COMMUNICATION

5.1 Communication Issues

As in all five companies, communication was a quintessential component of managers' work at 'Fashion'. In all functions managers were engaged continuously in communication, much of it oral and usually face to face. The morning 'breakfasts' of the floor managers and Directors, at 'Souhtown', the ongoing chat between managers and their staff, and between the managers themselves, were all indicators of a traditional, low-hierarchical familiarity. It seemed that functional and hierarchical boundaries were easily traversed, as evidenced by the daily talks between the young production co-ordinator and his local Directors, and his weekly consultation with senior executives at the London H.Q. And conversations between the 'St. Davids' computer manager - actually a low tier position - and the company Chairman took place monthly. The recently appointed General Manager (F-12) of a new label appeared to have frequent and useful talks with many other managers, including his M.D. - as he said: "You can get involved in any part of the business here - there is little structure and no secrecy".

Managers often quoted lack of co-ordination, especially between production and marketing, design and production and the two independent computer centres. All evidence of a general looseness of definition of structure, responsibilities and authority. Managers also claimed to know of no strategy in the company. Because of this culture of low structural definition, it would seem oral communication were rich - and had to be to offer ongoing tactical co-ordination and control, less available through other data channels than in the other four companies.
studied. The content of the oral transactions seemed to be almost entirely tactical and local - for instance two of the interviewed Directors said they were never involved in discussions of long term plans.

Generally the impression was given of a conservative management within which I.T. had not been regarded as a priority: F-7 "We have been trying to persuade a senior Director of the usefulness of computers in manufacturing for six or seven years ... it's a hard task, any new ideas are dangerous, no new suggestion has merit".

Thus computer systems were being installed within a relatively low - innovative ambience, characterised also by informality, lack of structural definition, and rich oral processes. It is not surprising therefore that I.T. had as yet made little impact on communication practices at 'Fashion'.

Systems had been entirely paper-manual-mental until ten years previously, and computerisation was principally a "translation of the manual system, over-burdened by volume, into a computer image of it". (F-7). The company was at an early stage of using I.T., and thus producing 'print-outs' for information dissemination (rather than VDU's). Managers, bearing in mind the oral tradition, were faced with an increase in data definition in terms of format and timing, and an increase in data quantity - and all these were mentioned often in interviews. Most managers felt their time on information gathering, analysis and dissemination, and data quantity had increased in recent years. Paperwork was widely thought to have increased, and the usefulness of printed material was seen as improved, as had timeliness of data.

Managers most involved with I.T. systems claimed difficulties of understanding information had decreased, and that access of their subordinates to data had increased. These managers were spending one or two hours each day now on computer data issues, and obviously this work was being substituted for their
previously 'conventional' activities.

5.2 Summary

'Fashion' was characterised by low formality, and looseness of definition of roles, structure, boundaries and responsibilities. It has been an essentially non-technological, and oral management environment. Although computerisation was relatively new, and applied to only a few areas, information management was beginning to become more important. The more disciplined character of systems, and also data speed and access, was altering the focus of managers. However, the dissonance of more rigorous data systems, and the conventional practices, were more apparent here than in the other companies. Managers were perhaps facing transitions and choices in this early stage of I.T. use, which the other companies have passed through years ago.

6. MANAGERS AND DECISION MAKING

6.1 Decision Issues

As has been discussed earlier, there was little long term planning in the regime at 'Fashion', at least in a written down, or pronounced, form. That there must have existed a set of guiding policies is self-evident, for the company had an obvious internal coherence as expressed by the commonality of approach by the managers interviewed, and the successful continuation and expansion (the new brand label) of the business. Decision making, then, amongst the managers surveyed, was taking place within a framework of relatively consistent internal and external factors, (production methods, operative performance, market needs, costs and pricing) well-known to, but rarely articulated formally by, managers. Rather, all these factors were a natural part of the largely local and tactical arenas of managers.
Because the operational methods were longstanding, and thus eminently well-known to staff, managers were engaged primarily on monitoring activities, scanning for deviations, and taking a stream of small, though vital, decisions to keep the various functions operating satisfactorily. Propositions of a strategic, or large-scale, or pertaining to a major change of method, were not mentioned by managers. On the contrary, there were several comments on the lack of decisions: "I don't see decision making happening, ... decisions are becoming more difficult ... the question is - are people in management sufficiently competent to handle the complexities?" In Personnel evidently there had been a longstanding concern for developing a more professional policy, particularly for management training, but over the years, these major issues had not been resolved. Again, the 'Westholt' computer manager and staff were frustrated by the absence of decisions on I.T. applications, and had spent their time "picking-off pieces". Much energy had been expended in convincing 'old-school' senior managers of their own professionally-based assessment of larger-scale, and co-ordinated, projects, but to little avail.

There was, then, a high level of 'certainty' amongst managers. Although bemoaning the lack of major decision making, at least they knew where they stood, perhaps summed up by a senior manager: "The company has made a profit every year since 1912, but I don't believe there is any danger of us being taken over, so everything should be O.K. The company is totally secure, people don't get sacked here - we are fairly contented". This ingrained 'certainty' bolstered managerial authority in their local and tactical terrains, especially as there were few 'professionals' in terms of technology, production, distribution or management development, who might challenge their realms.

At operational levels increased data speed, and accessibility, and to a less extent, better reliability of data, all related to increased I.T., were quoted as improving decisions. Certainly these factors allowed faster response to internal and external influences (the factory, to absenteeism and required changes in
production schedules; the warehouse, to requirements of shops). This faster data speed was in data reformatting, by the computer, in producing print-outs, and offering instant database interrogation. (No electronic mail as such was available in the company). As has been noted elsewhere, increased data speed and increased data accessibility, were themselves stimulating managers to request more of the same. Whereas previously garment allocation to shops from the warehouse had taken six weeks, it now took eight days. But several managers mentioned the need for much improved communications with the retail outlets so that sales could be specifically known in near real-time. This would allow stock reductions in shops to be made good within a couple of days - considered to be an important marketing factor.

I.T. then, facilitated more rapid operational decision making, and a reduction of 'work in progress', in terms of physical products, and in process time for authorisation paperwork.

Generally, there appeared to be an increase in uncertainty within some managers, possibly partly because of the spread of access to data bases increasing organizational transparency, and partly because of the early, but growing, awareness amongst managers, of the potential for change that I.T. conferred.

6.2 Summary

As in other management arenas, I.T. was introducing faster and more reliable data and better data access for decision making. The new ideas and capabilities clashed with the longstanding and conservative practices, particularly of senior management. But for junior and middle managers also, their primarily 'monitoring' mode, leading to streams of relatively minor operational decisions, was being pertubated by systematic data management. Paradoxically, although this reduces their 'certainty' of view, some managers recognised the advantages and were asking far more.
7. SUMMARY OF I.T. EFFECTS

The whole process of designing fashion clothes on a seasonal basis, the consequent rapidity of detail change of product, the virtually exclusively manual production, and the relative looseness of systems and structures at 'Fashion', are in striking contrast to the engineering companies previously described. These differences in culture and structure seem to parallel the differences in the products: flexible fabrics at 'Fashion', mechanical metals at the other two companies.

The take up of I.T. and its effects on managers are obviously much influenced by 'Fashion's' culture. There is no automation, robotics or electronic mail and only one personal computer. Systems are generally not sophisticated and computerisation has been applied in only a limited way. The company is thus at an early stage in its I.T. trajectory. Virtually all practices are traditional and perhaps clung to by managers with a long and successful experience in the 'rag' trade. Throughout the discussions with managers rang the theme of the new computer systems conflicting with the established order.

Nevertheless, I.T. is directly changing the areas to which it has been applied. It is an increasing element in the roles of factory and warehouse management. Their operational routines are tightening, with more precise and clearer data informing their work. Information management, though these managers would not call it that, is slowly becoming more central. Data access, reliability, quantity, clarity, format and usefulness are now matters of daily debate - undoubtedly stimulated by the spreading I.T. systems.

Not surprisingly, especially as there is little senior management consideration of I.T. planning, computer systems have as yet been merely superimpositions on existing paper-based arrangements. Also to be expected, the new computer systems, with extremely limited terminal access to user-managers produces masses of print-outs, an indigestible menu to managers more
accustomed to discussion on the shop-floor. Managers are accommodating the tightening operational procedures but with reluctance. They are also aware of the increasing visibility through I.T. that senior managers have of their operations. Thus junior and middle managers are giving less attention and time to 'social' management, which until latterly has been the core of their work. Their jobs, however, remain very much the same: busy, fragmented, oral and with high emphasis on keeping the work flowing.

The senior managers are hardly affected directly by I.T., but even they, on deeper reflection, usually confirmed their emphasis was now more on information management.
1. THE COMPANY : Medium-scale designing, manufacturing and marketing of computing and communication systems; a sub-division of large U.K. based multi-national corporation.

1.1 History

'Integral' is the current result of a series of take-overs and mergers characterising the parent corporation, which is one of the largest electrical groups in the U.K. with a turnover of £5,540 million and a profit of £725 million in the year ending March 1985. Altogether, a network of over 200 companies, employing 180,000 people (in 1985) supplies power generation, industrial and telecommunications equipment, components and consumer products. Because of the many take-overs it is difficult to trace a lineal historical line for 'Integral'. There are managers still at 'Haydonwood', the H.Q. site, who have worked there for thirty years under successive company names, but equally there are many more who have come in from other corporation units, or from other companies. This may account for the relatively amorphous company identity.

At the beginning of 1982 a new management structure was created, and within it 'Integral' was formed, operating on two sites - 'Haydonwood' with 750 people, and 'Southtown' with 450 people. (In fact, the 'Southtown' plant had been set up in 1978 by the previous management).

'Integral' is, then, a small company, in a giant federal corporation, expected to stand on its own feet, but had not enjoyed high success over the last several years, culminating in the re-organization of 1985. (See Figure 4.16 for results and manpower).
Figure 4.16  

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<th>Profit/Loss Before Tax £'000s</th>
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<td>1362</td>
<td>6016</td>
<td>(422)</td>
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<tr>
<td>1972</td>
<td>1031</td>
<td>3672</td>
<td>(205)</td>
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<td>1973</td>
<td>789</td>
<td>4142</td>
<td>(47)</td>
</tr>
<tr>
<td>1974</td>
<td>813</td>
<td>3315</td>
<td>(232)</td>
</tr>
<tr>
<td>1975</td>
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<td>(340)</td>
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<td>1066</td>
<td>23660</td>
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</tr>
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</table>

* Highest

(Note: Exactly coincident with the start of this study, the company announced a new M.D., the intention to restructure the organization, and 100 redundancies. Managers (and all staff) were concerned, and their attention was much focussed on the survival of their own jobs, where in the new arrangement they would be, and what changes of direction would ensue. With these issues hanging over them, managers found greater than normal difficulties in responding to interview questions. As a partial solution to this research - method problem, interviews were conducted over one year, and to an extent, the later interviews did show the organization was 'settling down'.

On all themes, subsequent analysis of managers' commentaries showed a neutral, almost irresolute, quality which may have been due to the re-organization. On the other hand, there were indications that this quality was inherent in the culture.

In any event, the data gained from 'Integral' has been dealt with in the light of the radical changes that were concurrent.
with the study, and which appeared to be much more powerful in the short term, than any implications of the increased use of information technology).

1.2 Organization

The new organizational structure comprised three divisions: Commercial Products, Data Systems and Military Systems. The Commercial Products division corresponds well with the operation at 'Southtown' where most of the interviews were carried out.

There are central personnel, quality, site services, financial and public relations functions, plus relatively self-contained product divisions. (See Figure 4.17).

The company designs integrated systems for a diversity of applications in industry, commerce, research and defence, and although computer hardware and software are the products, the emphasis is on designing appropriate systems. Components, and sub-assemblies, are bought-in, and 'manufacturing' consists of wiring and assembling items to form the finished computing and telecommunications equipment.

1.3 The Study

Twenty interviews were carried out, and of these people, fourteen returned questionnaires. In addition one non-interviewed manager completed the questionnaire. (See Figure 4.18).
Figure 4.17

Organization

Managing Director*

Central Functions

Quality Finance Personnel * Site ** Services

Divisional Manager* A (Commercial Division at 'Southtown')

Divisional Manager B

Divisional Manager C

Quality Assurance * Marketing ** Customer Services *** Technical Commercial ****

Production *****

* = Manager interview

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1.4 Summary

'Integral' with a current labour force of 1,200, and a turnover of £26 million in 1983/84, is a medium-sized company, within a huge U.K. corporation. Its products are complex industrial/commercial electronic systems. At the time of this study organizational restructuring was taking place in a somewhat pessimistic ambience.

2. I.T. IMPLEMENTATION

2.1 I.T. Culture

'Integral' is one of 200 companies comprising the corporation, which is headed by a chairman of considerable stature. During the 1960's and 1970's the corporation was created by many mergers and take-overs of companies diverse in size, products, markets, profitability and management style, but all in the
broad field of electrics.

There is a clear corporate business policy - to maximise financial returns while allowing high autonomy to management of the individual companies in terms of products, markets and personnel. Financial indices are scrutinised by corporate central executives continually, and explanations of figures sought of company managers at any time. A senior manager in one of the group's companies commented: "You don't last long if you show a loss. (The chairman) will shut you down if you're in the red for more than one annual report". (From an article in 'Computing', 26th September 1985). In an interview with this researcher a company M.D. (within the Group but not of 'Integral') explained that the chairman would personally ring him up, at virtually any time to query figures in his most recent report - and he expected detailed explanations of variances.

'Integral' designs, produces and markets computer systems used in industry, communications and defence; in the latter case commercial equipment is 'ruggedised' to withstand military applications. The company has enjoyed a measure of success and quotes a list of 150 user organizations. However, an attempt to penetrate the business applications market has been unsuccessful. 'Integral' had entered into a partnership with an American office equipment company to produce a machine suitable for the business computing market. In fact, the machine became long overdue and failed to meet promised specifications. Launched in May 1983, by the time of this study (1984), the company had gained few sales for this equipment.

As a consequence on 1st January 1985 a new Managing Director was appointed and announced: "It is my intention to restructure the company into three operating divisions, each under the responsibility of a Divisional Manager. Each division will operate as a business unit of the company and will, when fully established, undertake development, manufacture and support of products appropriate to its market place. Divisions will also
contain marketing, commercial, and quality assurance functions related to their activities. It will be the responsibility of the Divisional Managers to develop the market for our products and to ensure that they have suitable products to meet market needs. Overall divisional objectives will be established annually by means of divisional budget plans. Performance against these plans will be monitored monthly."

However, all the interviewed managers felt that to date there had been little or no long term plan, at least known to them. I-3 (Technical): "We have never had a product strategy - we have tended to respond to customers' requirements - 'customer driven' was the previous M.D's proud boast. Why haven't we had a strategy? We had a strong engineering department and engineers like technicalities but they don't have the market sensitivity. The parts of the jig-saw were O.K. but the total picture was weak. Engineering development was strong and well planned - but we did not have a sound marketing department. It is a very difficult market to predict because technical development is so fast".

I-4 (Production): "There is little strategy anywhere - until last year we took any order placed before us, and this got us into a lot of trouble. Perhaps, because we are a smallish company trying to play a big company game, there may be insufficient corporate support for us (at Group level)". I-12 (Production): "I have never seen any long-term plan - in fact strategy is vague". In Personnel a similar story emerged. There had been little Personnel planning even though recruitment and management of high technological personnel was recognised (by I-1) as difficult and sensitive. One senior manager perhaps encapsulated the scenario: "There is basically no coherent strategy in the corporation - each company is on its own - and we have been event-driven for ten years or more".

2.2 I.T. Applications

In 'Integral', and also in 'Components', the second electronics
company, it was much more difficult to discover the pattern of implementation than in the other three cases. Naturally, electronics is fundamental to both companies, and I.T. for managerial processes does not necessarily have a strong visibility in contexts where I.T. is the product and is also used widely within the design and production processes. For instance, in 'Integral' there is a long tradition of using computers in technical design of hardware and software, certainly since 1967. C.A.D. (Computer Aided Design) is essential there for printed circuit boards and other components.

Looking now at I.T. for managerial purposes: the corporation had set up a 'central' computer services company ('Services') at a distant site, which offered a menu of services at a price to other constituent companies. The forerunner of 'Integral' began to purchase some of these services on a small scale around 1975, and this process has gradually extended, the initiative being apparently left to individual department managers.

In 1979, consultants were brought in to design a strategic management systems plan, and a Head of Management Information Systems was appointed. I-4 commented: "The one attempt at integrated systems failed to attain support from line managers, ... was badly managed". No guiding working-group on management systems was set up, and it seems this project petered out. Senior management seem not to have regarded management systems as especially important, and anyway were no doubt focussed on the gathering problems of product development, and marketing.

Nevertheless in Finance, perhaps two thirds of the work is computer based, with various print-outs circulated to appropriate managers, the work being done by 'Services', i.e. outside 'Integral'. There were complaints about slowness of information access - "but as price for processing is for quantity not speed, there seems no incentive to improve". (I-9).

It was in Manufacturing that currently there was the greatest
impact of I.T. in systems as a package (MECCA - Manufacturing, Engineering and cost-control Applications), from 'Services' was coming into use. Importantly, as implied in its title, this package integrates several sub-functions. The system updates priorities between customers' orders, and produces component allocations to these orders, and labour usage plans, to give the best 'fit' with these priorities. "Kitting lists (inventory) are produced by the system and components not-to-hand, displayed. The computer is so precise - buffers in the system - both paperwork and physical stores - are reducing". (1-4).

Over the previous two or three years systems installation had accelerated, with batch processing being replaced by on-line terminals. There were twelve VDU's and two printers amongst the 160 people in stock control, and doubt was expressed by I-11 as to whether the system could now work at all without computers, because the lead times had so reduced. There was still much human checking of stores by hand, and making out requisitions manually - according to I-7 - because "the system doesn't have sufficient information about future orders, and I do. I change buffer levels (of stocks) from my experience". This picture of mixed P.M.M. and I.T.-based systems, with the obvious problems of transition was common. The impression was of an organization learning, and of scope for considerable extension of computer systems. The problems discussed seemed often to be associated with lack of understanding of the computer system by managers or the poor fit between the I.T. system and the remaining paper-based arrangements.

In Marketing, and in Personnel, there was slight I.T. application, though the potential was understood by managers.

I-20 perhaps summed up the overall picture: "The financially conservative culture is the strongest force ... the management systems have not been designed anyway - and the managers have not been involved in systems considerations. We use the lowest common denominator - paper".
The paradox (a word which springs easily to mind in considering I.T.) of 'Integral' is that the company is centred upon electronics, with many I.T. experts, and products, yet I.T. in the management arena had been guided by little planning, or even by senior management interest. The functional managers had been left to take their own initiatives about computer systems, and not surprisingly, the diffusion and use of these, has been patchy and spasmodic. Nor has there been real attention to training of managers in this field, or organization design catering for possible I.T. systems.

In implementation then, 'Integral' is quite different from the non-electronic environments of the two mechanical engineering companies where management applications of I.T. are following a planned, if patchy, development. Here, in spite of the extent of I.T. expertise, and availability of hardware within the company, computer systems have been bought in, and 'bolted-on' with low commitment from managers.

3. THE CHARACTER OF MANAGERS' WORK

Throughout the interviews it was clear that although the company was heavily involved in information technology, managers gave little importance to I.T. as a management tool, or saw it as a major change force in the company. Overwhelmingly, achieving a future viable product range, the relative failure of a key current product, and above all, the re-organization, held their attention.

3.1 Involvement of Managers

The managers were divided into three groups: systems experts (from a management viewpoint) (A), of which there were two; managers well implicated in I.T. activities (B/C); and managers little involved, or not involved, in I.T. based work (D). (See Figures 4.19 and 4.20). Managers were in general more involved in I.T. based activities than in the three companies discussed.
previously, but as 'Integral' is solely engaged on I.T. design and I.T. product manufacturing, and care had to be taken to distinguish between technical use of I.T. and its managerial use.

Figure 4.19 Pattern of Interviews and Questionnaires

<table>
<thead>
<tr>
<th>Tier</th>
<th>Questionnaires</th>
<th>Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B/C</td>
</tr>
<tr>
<td>1 &amp; 2</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>TOTALS</td>
<td>-</td>
<td>7</td>
</tr>
</tbody>
</table>

Questionnaires: 14 Interviews: 19

(1 from non-interviewed manager
13 from interviewed managers)

TOTAL GROUP = 20 MANAGERS

b.

<table>
<thead>
<tr>
<th>Function</th>
<th>Questionnaires Tier</th>
<th>Total</th>
<th>Interviews Tier</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/2 3 4 5</td>
<td></td>
<td>1/2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>M.D. and Gen. Man.</td>
<td>1</td>
<td>1 2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Finance</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Technical</td>
<td>1 1 1 3</td>
<td>2</td>
<td>1 1</td>
<td>4</td>
</tr>
<tr>
<td>Manuf'ng</td>
<td>1 2 2</td>
<td>5</td>
<td>1 3</td>
<td>2 6</td>
</tr>
<tr>
<td>Marketing</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Systems</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
<td>1 1 1</td>
<td>3</td>
<td>1 1 1</td>
<td>3</td>
</tr>
<tr>
<td>TOTALS</td>
<td>3 3 5 3</td>
<td>14 5 4</td>
<td>7 3</td>
<td>19</td>
</tr>
</tbody>
</table>

- 196 -
Figure 4.20  I.T. Involvement* of Managers

<table>
<thead>
<tr>
<th>Function</th>
<th>A</th>
<th>B/C</th>
<th>D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.D. &amp; Gen. Man.</td>
<td>2</td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Finance</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Technical</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Manuf'ing</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Marketing</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Systems</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Personnel</td>
<td>4</td>
<td>4</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>2</td>
<td>8</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

* Involvement primarily discriminated on time spent on systems issues, on direct use of terminals or personal computers, on electronic mail usage, and on apparent amount of interaction with computer produced data.

b.

<table>
<thead>
<tr>
<th></th>
<th>B/C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDU in office: per manager</td>
<td>.8</td>
<td>.5</td>
</tr>
<tr>
<td>Personal Computer: per manager*</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of packages used daily</td>
<td>2.0</td>
<td>.3</td>
</tr>
<tr>
<td>Hours/week in systems issues</td>
<td>1.5</td>
<td>.9</td>
</tr>
<tr>
<td>Minutes/day on terminal or PC</td>
<td>100.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Electronic messages sent/day</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

* (Note: Some managers comment in the text about PCs obtained after this survey was taken).

As in the other companies, the apparent involvement of managers varied widely, and was function-related. Only in Manufacturing was there a distinct expressed awareness of I.T.-induced change.
Managers in this function had been wrestling with the MECCA production control system (imported from the 'Services' company, and to which they had zero contribution in terms of either its design or implementation) for over two years, and the bout continues. No attempt had been made either to prepare managers for the system - the learning process was entirely by doing. 1-11: "I.T. is affecting my job greatly - the biggest problems is understanding the info the computer gives me - and it's usually too much. So much data is not required because we do not yet understand the system". In this function the average use of a terminal per day amongst five managers was 98 minutes each, compared with 20 minutes each for nine managers in other functions.

In spite of this relatively high use of VDUs, a great deal of computer produced paper was in evidence. For instance, the monthly Quality Assurance report, circulated widely, was 25 pages of dense statistics. And managers were having obvious difficulties with determining data relevance, priorities and value.

The Technical function, using well-established I.T.-based arrangements for technical issues, seemed not to be much involved in management I.T. systems, although the 'project tracking' facility by computer was regarded as useful by managers. However, 1-5 averred that I.T. had not affected his job: "'Integral' is not as advanced in management systems as I.C.L. was fifteen years ago. Perhaps it's because we have a small product range, and long runs". Again in this function, P.M.M. arrangements were still prime: "Mountains of paper are produced - though I am forcing myself to use I.T. more in spite of the company pressure to keep up the traditional paperwork". (1-3).

This transitional situation in which part of systems are I.T.-based, and part P.M.M., existed also in Finance. "The data elements which are needed rapidly for better control of events" (1-9) were computer based, while certain data handling stages
which needed "high security, or special professional care", were handled manually. Much of the costing analysis of a 'decision support' nature was accomplished by computer, though according to I-9, the system was not working well because of mismatching of data - again perhaps a transitional problem.

Virtually no I.T. usage was apparent in the Personnel (including training) function, although 1-14 claimed it was influencing the nature of the job quite considerably: "With personnel records on a PC (instead of on the main-frame - which was a disaster - we get more time for interpersonal issues and spend less time on routine data work. I can thus supply a better service to line managers, - for instance on manpower planning".

Although I.T. involvement was unique for each manager, two-thirds of those interviewed felt that their knowledge, and use of electronic systems, and data bases, had increased over recent years.

What was especially noticeable, in an electronics company was the sparse use of electronic mail, even though there were many references to geographic and functional isolation. This is in complete contrast to the situation at 'Components', where e-mail was used in a common-place way.

3.2 Pace

Although the company was in turmoil at the time of this study due to a re-organization, and redundancies being announced, there was little impression of fast pace anywhere except in Manufacturing. It was acknowledged by several managers that "energy" was low in many functions, and also that Manufacturing was "work-load driven" and more frenetic.

Half the managers felt the pace of their jobs had quickened over recent years, though a quarter saw no change. Most managers related increased pace to greater use of on-line I.T., in place of batch processing.
The Technical, Personnel, Training, and Estates managers, where little management I.T. was being used, made few comments about pace, or associated increased pace with I.T. use. In contrast Manufacturing managers were obviously concerned about pace, though it was not necessarily associated with use of computers: the impression was given that this function had perennially been frenetically busy. Computer systems, however, did provide increasingly fast data, and fast response. I-4: "I.T. actually gives me more to do in the same time - there is more data to assimilate - it's easier to get data and that helps decision making. But the pace is hectic and getting worse". Two managers in Manufacturing independently described in similar terms the inability of some parts of the function to respond fast enough to the situations, now being revealed extremely quickly, by the computer.

3.3 Fragmentation

As found in all the companies, managers appeared to have highly fragmented work, and it did appear that pace and fragmentation were associated. Managers in Manufacturing particularly commented on the broken nature of their jobs, typified by I-11: "I get involved in perhaps two dozen issues in a day - meetings on progress, spend patterns, stock control, computer input troubles - not much time for reflection on (personal) planning". Similarly, I-7: "I'm not efficient in the use of my time - not well planned - most of my job is fire-fighting - going from panic to panic, there is no routine".

There seemed to be less job fragmentation in all other functions, although it was common for managers to have little idea how they were using their own time, nor to do much, if any, planning of their time. No discrimination was detectable between B/C, and D, managers in terms of degree or role formality, extent of routines, or the amount of rules and regulations in their jobs. However, 60% of managers claimed their time on routine activities had increased.
Time for reflection was not considered to have much changed. Neither was there hard evidence that the degree of proactivity had altered in ways related to I.T. The overall impression was that each function had an historic character in terms of proactivity - reactivity, and that character continued independent of the extent of I.T. usage.

3.4 Planning and Time Horizons

The re-organization of the company, the redundancies, and the lack of business success over recent years, contributed to the uncertainty about the future direction of the company, and probably heavily conditioned managers in their comments about the relatively formal planning components of their roles. Fifty per cent of managers claimed they now gave more emphasis to strategy, 60% thought they were focussing on a longer time horizon, and 85% said the planning elements of their roles had increased. Undoubtedly computer systems in Manufacturing were forcing a more disciplined planning approach. However, as was found elsewhere there was thought to be less planning of their own time, with I.T. prompting more reactivity.

Woven into many managers' comments was the thought that because information technology is changing so rapidly, and often so unpredictably, with various hardware and software features developing at differential rates, product planning and anticipation of markets, is difficult in the extreme. This idea is linked with the relative lack of success in recent years, and especially with the abortive product development initiative with the American office equipment company mentioned in section 2.1. I-4, for instance: "The company has been so messed about for the last two years that there has been no time for planning". In this context, no evidence was evinced that I.T. applications were altering the time horizons, or planning orientation of managers, except in Manufacturing.
Managers gave little importance to I.T. as a management tool, nor was it seen as a major change agent. Because of the electronics and systems nature of the companies' products it was difficult to distinguish between technical and managerial use of I.T. Only in Manufacturing was there a distinct awareness by managers of I.T.-induced change, and there transition issues were common. Increased I.T. systems in that function produced data relevance and priority problems and stimulated pace. Fragmentation of work was common and was independent of I.T. Managers felt I.T. might be increasing the extent of formal planning, but reducing informal, personal planning.

4. MANAGERS AND PEOPLE

4.1 Numbers of People

With the 100 people made redundant in January 1985, the total reduction in staff since 1980 was 33%. Sixty per cent of interviewed managers said numbers of people at shop-floor and in clerical positions had reduced. However, it proved impossible to link I.T. directly with these reductions because of the changed boundaries in functions and alterations in job titles. Undoubtedly the main reason for a smaller labour force was reduced order book. Nevertheless there were areas where increasing I.T. was patently lowering the labour required for a given output. In Manufacturing a machine for fixing components on a printed-circuit-board was so fast that all the company's work of that type could be handled in two shifts a week, whereas previously 'several' workers had been employed every day, and this exemplified the extent to which computer-aided automation is changing shop floor activities in the electronics industry. Another productivity gain is produced by the replacement of several components by a much smaller single multi-function item, as the developments in I.T. continue to increase the capacity of components (for instance computing power or memory) for a given
size. These effects reduce the total number of components, manufacturing operations, size of the complete assembly, and thus labour required in production. This is illustrative of the complexity of the changes produced by I.T. associated as they are by several interwoven characteristics of the technology - discussed in Chapter Two.

The current pattern of manager responsibility is shown in Figure 4.21.

Figure 4.21 Manager Responsibilities for People

<table>
<thead>
<tr>
<th>Tier</th>
<th>Nos. of staff reporting directly to manager</th>
<th>Nos. of staff manager responsible for:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>1/2</td>
<td>4</td>
<td>2 - 7</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>1 - 6</td>
</tr>
<tr>
<td>4</td>
<td>4.5</td>
<td>2 - 5</td>
</tr>
<tr>
<td>5</td>
<td>3.5</td>
<td>3 - 4</td>
</tr>
</tbody>
</table>

(By far the larger numbers of total staff reporting to a manager were in the Manufacturing area).

No hard evidence was forthcoming that the numbers of other managers reporting directly to a particular manager had changed, though most interviewees felt the total number of people within their responsibility had decreased.

4.2 Skills of People

Managers commonly quoted downward trends in proportions of unskilled and semi-skilled staff, and upward trends in the proportion of skilled and professional staff. Often managers talked of difficulties in recruiting, and holding, the necessary highly qualified and experienced I.T. and systems staff, though
there did not appear to be a personnel plan to cultivate management practices which might address this problem. (This was in contrast to the situation found at the other electronics company, 'Components', described in the next section).

Because of the rapid technological advances, technical training had always received emphasis, and was regarded as satisfactory by technical managers. However, training was regarded as weak throughout the company especially in the area of management and supervision, and also in ongoing preparation for increasing management systems. I-8 (Personnel): "On the technical side we probably have a grip on training, but on the management and supervisory side there is lack of a coherent approach ... we seem to operate as a manufacturing company rather than a computer company like 'Logica' where managers are younger, and there's a real training emphasis. It may be that 'Integral' is being run like 'Traffic' (another of the corporation's companies) when it should be more like 'Logica'. There has been a lack of leadership in Personnel and Training here by the previous M.D."

The 'Southtown' Personnel department was almost entirely occupied by the on-going matters of recruitment, welfare, and administration, and no time had been directed at organizational development, or in planning or preparing staff for management systems. Comments from I-9 (Finance) were typical: "The company has not helped me at all in leading me into my new role ... Managers need to be educated into managing their departments, (but in this company) managers leave it to other managers to manage". No manager had had much, if any management education, and virtually no preparation for I.T., and its implications. Several managers expressed surprise that with the availability of their own technology and expertise, the company had not done more in training managers in its use. I-4 (Manufacturing): "We are the worst people at using our own technology".

I-11 explained that there had been no preparation for the new
on-line system (VIECCA), and that his current biggest problem was understanding the new system, particularly what information was actually available.

In a commercial department, I-13 (recently appointed to that position) had been trying to organise a short management development course for his principal team leaders for over a year but his initiative had been frustrated for various reasons - it was difficult to row against a culture of low priority for (non-technical) training.

4.3 People Management

'Integral' was essentially a 'high tech' company: it had traditionally been technology led, and other functions felt themselves to be subordinate, and responsive to the technical needs of product and of customers. In virtually every interview this orientation was conspicuous. Questions in the 'people-management' area were largely answered blandly. No change was reported, for instance, in the 'management of people' content of their immediate subordinates, and little change in their own time on 'people' issues, in time spent talking with their immediate subordinates, or in the formality of their roles.

It seemed that the previous M.D. expressed little interest in the issues of organizational development, personnel development, or in creating a 'management of people' priority. Nor was there any 'preparation for I.T.' policy. Thus managers were left in a "laissez-faire" atmosphere with no coherent personnel style and policies.

4.4 Summary

Labour numbers were reducing though few specific correlations with I.T. use were forthcoming. However, managers usually implicitly linked I.T. with reduction in staff. Unskilled and semi-skilled people were reducing in number, whilst the
proportion of skilled and professional staff was increasing. Training and management development had a low priority. The company was essentially technically led without a strong policy or style in the field of management people. The use of I.T. did not seem to affect this approach.

5. **MANAGERS AND COMMUNICATION**

As in all the studied companies communication was patently a key component in all managers' roles. Managers frequently reported that data issues were central, and large, in their work.

5.1 **Structural Issues**

The two rather distinct markets, namely commercial, and military, impart a bipartisan flavour to the operation, especially as the two groupings are on separate sites, 25 miles apart. Further, head office is located at the 'Haydonwood' plant, and there was a definite feeling amongst managers at 'Southtown' where most of the interviews were conducted that they were isolated from the main-stream of the company. There was little use of e-mail to reduce this isolation, which was in contrast to the e-mail usage at 'Components', the other electronics company. In fact, there were many strong dissimilarities between these two companies even though their products, personnel and size were comparable. It was especially noticeable that the company culture regarding using I.T. for management purposes was entirely different and has engendered a rather limited and lack-lustre utilisation in 'Integral', and a widespread and enthusiastic use in 'Components' - seen for example in electronic communications. Also, at 'Integral', as the computer assistance was bought in from the corporation's 'Services' company, with decisions - in keeping with policy - being left to department heads, there appeared to be a low systemic cohesion between function-based systems, for instance between design, and costing. 1-5 in Technical explained: "My area is really a separate issue - my own budget - each function, i.e. marketing or manufacturing, is separate. The company is
primarily run by Engineering (of which he was a part) - most people want to be in control of their destinies". It was interesting that this very bright manager explained at great length the importance of interfaces in the company's technology, but did not see the parallel in organizational terms.

There were other examples in Computing Services, Personnel and in Manufacturing. 1-4 (Manufacturing): "There is some integration between functions, but it is not tight. However, boundaries are weakening - for instance, I'm getting much more involved with cost control, and manufacturing techniques. I have a lot of communication with Engineering because of new products, and a little with Sales because of past sales. There is certainly no integration of systems in the company and no group looking at these issues". 1-12 (Manufacturing): "People in Factory A do not know what's happening across the road (literally) in Factory B. I don't feel we communicate well ... for instance, there is a paradox in that we have all the technical equipment to do the job - but we don't use it. 'Components' are miles ahead of us on computers used as management aids". (He did not know this research was also taking place at 'Components').

The whole picture was one of geographical and functional isolation, with departments able to be self-contained. Data crossed boundaries, because that was necessary, but there was a widespread tendency for managers to be less than positive about other departments. In particular it became clear that the company was driven from Technical function, from which came the principal forces for success or failure of products.

There was little evidence of I.T. altering this pattern. Decisions on hiring in packages from the 'Services' company seemed to have been taken without an overall cross-company policy. E-mail, although technically well understood and available, was used only slightly. Managers hardly mentioned it as an important management aid (again in contrast to 'Components'). I.T. seemed not to have changed the apparent
degree of integration or amount of boundary crossing. However, it was clear that the nature of the product (i.e. I.T. based) was causing a deeper integration of quality (control) into both the design and manufacturing functions. Several comments indicated a drawing together, an interdependence of the three functions. I-13: "Quality control is closer now to Production and Design engineers - quality has become embedded in the total system: it is no longer just 'inspection'". And I-17: "The test engineer has to live closer to the design engineers". (It was in Manufacturing, and Technical Design that I.T. was being most used).

5.2 Data Issues

Ninety-two per cent of surveyed managers felt their involvement with information gathering, analysis and dissemination had increased, and three-quarters perceived the quantity of data they were using had increased over recent years - this was especially noticeable amongst managers most involved with I.T. usage.

Quantity of data, the difficulties of relevance in computer produced information, and speed of data availability, were information management issues most mentioned by managers. I-5 (Technical): "There's far more data than I need - there's no way I can find time to plough through the print-outs - it's so easy to print paper, so we do. I take a 2 inch thick pile of paper to a meeting - paper still is the easiest to use". This kind of comment was made by all the I.T.-involved managers. It was interesting that in such an electronically technological company managers did not seem to be widely using VDUs. For instance, I-17 (Technical): "I have considered having a VDU and decided against it. I get computer data with print-outs and that's O.K.". The same manager did point out that time in meetings had decreased as a direct consequence of each participant having identical, and unarguable print-out data. The inference was that previously meetings had been used to share data, and to validate data accuracy, and these processes
were now taken over by the computer system to an extent.

Questions regarding information flow (difficulties in knowing with whom to communicate; understanding of senior managers of work done; time spent dealing with other departments; amount of consultation with more senior managers) in relation to I.T. use all provoked "no change" replies. However, the access of immediate subordinates to information available to their managers, and time spent talking with immediate subordinates, were both claimed to have increased. But neither of these issues could be ascribed to I.T.

5.3 Oral Communication

Although it was impossible to derive quantitative data, managers in this company seemed to be less oral than in the other three companies so far described. This may be related to the high theoretical value embedded in the product, and its design and manufacturing. There was a high amount of 'thinking' time on the part of technical managers, and this coupled with the relative independence of departments, and the low numbers of manual and unskilled personnel, may have contributed to the impression of lower oral communication. (In 'Components' oral communication was extremely strong).

5.4 Summary

The isolation of the 'Souhtown' sites, and the independence of departments, has not been changed by I.T. usage. I.T. does not appear to have changed the established patterns of communication except in manufacturing where the recent availability of on-line data, and a complex data-base system, appears to be integrating functions, and marginally increasing organizational transparency.
6. MANAGERS AND DECISION MAKING

6.1 The Decision Milieu

'Integral' was a relatively small company of a large and complex corporation, whose Board allowed high autonomy to local management, but closely and continuously monitored financial results. Little policy specific to 'Integral' appeared to emanate from the corporate Board (apart from the need to maintain financial success measured by a cluster of known indicators), though Directors of 'Integral' implied that they had guidelines from above, not necessarily known by their subordinate managers.

Management within 'Integral' was therefore responsible for developing and maintaining its own strategies, policies, management methods and styles.

The spheres of 'uncertainty' and 'decision making', as with all management activities, are fundamentally conditioned by the overall culture. While the financial expectations of the corporate Board were an essential element in that culture, it is a reasonable assumption that the extant milieu at 'Integral', in which decision making was taking place, was principally the creation of the relatively few senior managers involved over recent years.

As discussed under section 5.5, managers at 'Integral' seemed uncertain about long term plans. The lack of integration of 'Integral' into the corporate cloth, was reflected in a similar lack of integration within the company. Each function operated largely as a separate entity, within its own sub-culture. The predominant sub-culture was 'Technical', staffed by highly qualified and technologically-specific people, and orientated almost entirely toward the design and development of the product. Other functions were overshadowed by 'Technical', and were attempting to be responsive to their needs. Little marketing or customer orientation was expressed anywhere.
There was, then, a high level of uncertainty amongst managers at the time of this study, partly short term, due to recent redundancies and a total re-organization, but probably mainly longer term. Certainly, virtually all the managers felt that they were not involved in long term decisions and that there was no explicit strategy for I.T. Often this latter thought was coupled in a bemused way with observations about the company having the technological expertise, but not applying it for management purposes.

A derivative of this apparent lack of longer term considerations was the lack of emphasis on management systems, and a lack of coherence between systems, which were often mentioned. User-managers had not been involved in designing, or even contributing to the design, of systems.

6.2 Speed of data handling, and decisions

There was no doubt that where I.T. was being used it was associated with faster access to information, and in turn that was linked with more effective decisions. 1-5 (Technical): 'Everything is more rapid now; a bad decision is shown up by the systems very much faster. And, managers rising to the top are those prepared to make a decision in this more transparent environment". 1-4 (Manufacturing): "I can locate state of a particular order - almost instant information - and therefore I am a more effective manager". This system rapidity was unable to be matched by response in the Manufacturing function - and this led to frustration. (I-11).

At 'Integral', neither e-mail nor personal computers, were widely used, so these potential tools for increasing data handling speed were relatively absent. (Both of these were seen as important components in relation to decision making in other companies).

Although amounts of data available certainly increased in computer driven systems, and gave problems of sorting and
relevance, managers in Manufacturing believed they were better decision makers because of I.T. I-11: "I am a decision maker—and make a lot of decisions through the day... I think my decisions are getting better due to more computer data. It is, of course, always necessary to interpret computer print-outs, and we have to be more precise about what data we need. I don't have much say about systems design—but I'm not worried about that. We must be able to work within the (purchased) package—adapt our ways to suit the system".

6.3 Summary

'Integral' was passing through an especially difficult period due to market problems and reorganization. The resulting atmosphere was marked by uncertainty. This may have been short term, but certain features of the culture and structure—functional isolation, a lack of integration, and rather low attention to development of a coherent management culture, may all have contributed to this uncertainty in the longer term.

In general I.T. seems to have little effects on this environment. However in the function where I.T. is most applied, Manufacturing, the same I.T. influences were found as in other companies. Managers in that function believed faster access to data through I.T. resulted in more effective decisions, and a faster, and more visible presentation of results of decisions. Once again there were hints of increased vulnerability of managers where this transparency applied.

7. SUMMARY OF I.T. EFFECTS

Consequent upon market difficulties over several years, 'Integral' was in the throes of a radical re-organization during this study, and hence I.T. and its effects was not uppermost in managers' minds.

The company is long-established in the I.T. business and thus managers are well-versed in the hardware and software
technologies. This is a situation distinctly different from the other companies previously described. In spite of this widespread understanding there was no apparent plan for I.T. use in management processes apart from a policy to buy-in externally designed packages. Using computers in technical design has, however, been standard for twenty years. A highly integrated system is being introduced into manufacturing management, and it is in this function that most effects are noted.

Managers rarely give importance to I.T. as a management tool although they perceive their I.T. involvement as increased with benefits to effectiveness. Where I.T. is used it provides more data, more rapidly, but there are problems of relevance. There is little evidence that I.T. changes the sub-culture of any function - pace, the degree of reactivity, fragmentation, all seemed strongly related to the function itself. No evidence emerges that I.T. is changing the degree of integration between functions, or time horizons.

Numbers of unskilled and semi-skilled people are felt to be decreasing as a consequence of I.T., though exact numbers were not forthcoming, partly because of other concurrent changes, while the proportion of skilled and professional staff seems to be increasing. Technical training is regarded as satisfactory but there little priority is given to management development, or preparation for I.T.

There is a distinct feeling of isolation, at 'Southtown', associated with distance from Head Office, and with product division, and although the technology is available, it is not being used to address this problem.

Most managers feel their involvement with information processes have increased over recent years and this is most noticeable amongst I.T.-involved managers, who feel data timeliness has improved. Within Manufacturing greater integration and organizational transparency is noted.
'Integral' has a somewhat indefinite milieu regarding decisions, possibly associated with lack of financial success recently. The lack of coherent systems is also often mentioned.

Speed of data handling is seen positively in decision making. Most managers feel decisions have become more complex, but their decision making authority is unchanged.

I.T. is being applied in few management areas, and only in those areas is there identifiable implications on management roles. The non-I.T.-forces in this case (of lack of business success, the consequent re-organization, and historical culture) far outweigh any implications of information technology.

'Integral' is very different from the other companies already described, in that managers have a high level of technological understanding of electronics and software. In spite of this, the emphasis placed on this arena by managers is no higher than within 'Engineering' and 'Hardware'. Changes produced by I.T. implementation in 'Integral' seems to be less than in those companies, though patterns of change are similar. Once again, immediate effects appear to be dependent on local contexts. The later and deeper consequences on organizational culture, structure and processes emerge as basically similar to the other cases.
1. THE COMPANY: Large-scale; designing, manufacturing and marketing of electronic components and systems; U.S. based multi-national.

1.1 History

In 1930 two young scientists started a service in the U.S. which was based on electronic equipment. Thus began a period of steady growth with continuous developments of equipment and technique until the outbreak of World War II.

The sophisticated electronic equipment which the company had designed and built for its services - then the prime activity - proved to have military applications, and this led to a Laboratory and Manufacturing division being formed. By 1951 the manufacturing, and services, activities had both grown so much that each was created as a separate, but linked, corporate structure.

The early years were marked by a series of remarkable technological achievements, phenomenal growth and financial success. In 1957 the first plant outside the U.S. was located at 'Ouseford' ('Components'); and a second U.K. site was brought into operation near the South Coast in 1970.

1.2 Organization

The company's products are electronic components, and assemblies of these, marketed to other electronics companies or direct to user-customers. Rate of change of technology, both of product and of manufacturing, is rapid, and market demand fluctuates greatly year-on-year. The technical change rate requires high responsiveness, and personnel and organisational flexibility; characteristics which pervade the company. Organisation charts were not available: reporting and responsibility patterns
appeared to be a 'dynamic matrix', adjusting to internal and external requirements.

By 1985, 'Ouseford', (where all interviews and questionnaire surveys were carried out) had become a major centre for several company functions. The site houses the 'Services' company for Europe, Africa and the Middle East, and the management for some 700 overseas staff. There are also various technical departments involved in electronic circuit design (using comprehensive computer-aided systems) and in customer support. 'Ouseford' is also a major node within the world-wide corporation satellite-based computer network.

Thus at the site are located finance, research, technical customer support, manufacturing, marketing, data processing, personnel, and other services functions. Total manpower on the location is 2,300.

Computers have been used at 'Ouseford' (and throughout the company) since the earliest days, and on the site is massive mainframe computing power supporting hundreds of terminals and peripherals. (While the company was especially open in terms of access for interview, and in provision of data, there was a natural reluctance to give exact details in technological areas).

During the three or so years previous to this study large numbers of personal computers (which the company manufactures) were also being used widely).

1.3 The Study

Seventeen managers were interviewed and of these seven also returned questionnaires. In addition 21 non-interviewed managers returned questionnaires (giving a total of 28 questionnaires).

'Tier' positions appeared difficult for managers themselves to
define, job titles seemed not to be specific, and were little guide (to an outsider) of the job content.

**Figure 4.22 Pattern of Surveyed Managers**

<table>
<thead>
<tr>
<th>Tier</th>
<th>Interviews</th>
<th>Questionnaires (non-interviewed Managers)</th>
<th>TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tier 2</td>
<td>3</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Tier 3</td>
<td>12</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>Tier 4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>17</td>
<td>21</td>
<td>38</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Interviews</th>
<th>Questionnaires (not interviewed)</th>
<th>TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Managers</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Finance</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Technical</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Marketing</td>
<td>5</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Systems</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Personnel*</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>(* includes: 1 - Legal 1 - Buildings Maintenance)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>17</td>
<td>21</td>
<td>38</td>
</tr>
</tbody>
</table>
1.4 Summary

'Components' is a U.K. site, employing 2,300 people, of a U.S. based multi-national, whose business is designing, manufacturing and marketing electronic components and systems. I.T. has been used for decades and is an inherent and major factor in the organization.

2. I.T. IMPLEMENTATION

There appears to be a strong belief at the 'Ouseford' plant that the company "knows where it is going". This confidence amongst interviewed managers in company policies, and long-term thinking, is in marked contrast to the situation perceived at the other four companies. At 'Components' managers spontaneously referred to an extant strategic plan - for products, markets, personnel, and for information technology.

The entire environment at 'Components' was technological and electronic. With nearly 60 years of continuous research, development and application of sophisticated electronics, and nearly 40 years of computer hardware and software involvement, the company's staff regarded I.T. as commonplace. Paradoxically, they also usually expressed feelings of wonder about the potential and the 'magic' of the technology. All interviewed managers appeared to have a good inherent knowledge of computers, and telecommunications - the heart of the business, though naturally depth of understanding varied depending on the manager's background. However, the level of awareness of the possibilities of the technology must be regarded as of a high order (and much higher than in the other four companies).

(Of the 17 interviewed managers 15 had degrees, HNDs, or HNCs; 11 had degrees, 8 in electronics or physics, and two in technology).

Two characteristics of the business surfaced often: the pace of
developments technologically, and the volatility of the market place. Thus, while there were strategic plans internationally, for product and manufacturing process development, and for marketing, the company was always flexing to cope with market or technical vagrancies. Thus flexibility and responsiveness were organizational attributes absolutely needed to maintain viability.

Because of this ambience of technicality, rapid developments, flexibility and responsiveness, it was difficult to separate electronic activities related to product and process design and development, and those related to management. In fact, demarcations of any kind were not easy to discern. Powerful computer analysis, widespread networking, easily available printouts, instantaneous world-wide communication, personal computers and terminals, were available to all the managers, and were used in all functions.

There had been certain strategies for I.T. for many years - for instance, world-wide standards for hardware, and for international linkages. Similarity in certain technological activities and some management areas (for instance, finance) software and formatting protocols had been standardised for years.

In spite of this high level of strategic thinking there did not appear to be a coherent plan for using I.T. as a management tool, at 'Ouseford'. The potential for this application was well understood, but managers generally tended to be overwhelmed by the availability of technical resources, and seemed not to focus on the management applications and implications. "'Components' is fantastic in supplying PCs (after all - we make them), and we are swamped with software and experts to teach us - but I don't have enough knowledge on organizational systems". (C-1). "There is no clear plan on I.T. usage for management - except to improve data acquisition and analysis" (C-7). In a sense, as will be discussed later, the overall frenetic pace at 'Components' while conferring advantages in some ways, appeared
to militate against long-term thinking and coherence of management development.

Discriminations of the use of I.T. (as a management tool) between functions proved to be impossible. All functions seemed to have a similar level of general I.T. usage, and as mentioned earlier, distinctions between functions, on any matter, were difficult to ascertain.

3. THE CHARACTER OF MANAGERS' WORK

The average age of the interviewed group was 37, (and of the managers returning questionnaires, 39), with an average time in the company of 11 years, and incumbancy in present position of three years. Managers had moved around the company widely. C-6 was quite typical: Degree in Physics, 39 years of age, four years with another electronics company, then twelve years with 'Components', Quality Assurance Engineer, then Product Engineering, then Research and Development Team Manager, then General Manager of a product group.

3.1 I.T. Involvement of Managers

As has been described, managers at 'Components' used information technology in a commonplace way. It proved difficult to differentiate managers by their degree of involvement in I.T., firstly because of the predominance of electronics backgrounds, (see Figure 4.24 below), amongst staff, and secondly because of the abundance of I.T. facilities. The extent a particular manager was knowledgeable about the technical aspects of I.T. or usage of hardware, or of software, was no guide to involvement in I.T. based management systems, or awareness of them. (This was a feature also of the other electronics company 'Integral', and distinctively different from the situation in the other three non-electronic companies where knowledge of I.T. usually meant knowledge of its use in a management context).
Using the same discriminators as for the other four companies: time spent on systems issues, direct use of terminals or personal computers, electronic mail usage, and apparent amount of interaction with computer produced data, an attempt was made to separate managers into two major groups. B/C managers appeared to have a higher I.T. involvement, than D managers as shown in Figure 4.23 below.

Figure 4.23 I.T. Involvement of Managers

<table>
<thead>
<tr>
<th></th>
<th>B/C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDU in office: per manager</td>
<td>.6</td>
<td>.3 per manager</td>
</tr>
<tr>
<td>PC in office: per manager</td>
<td>.4</td>
<td>.1 &quot; &quot;</td>
</tr>
<tr>
<td>Number of packages used daily</td>
<td>1.9</td>
<td>.2 &quot; &quot;</td>
</tr>
<tr>
<td>Hours/week on system issues</td>
<td>1.6</td>
<td>.8 &quot; &quot;</td>
</tr>
<tr>
<td>Minutes/day on terminal or PC</td>
<td>6</td>
<td>3.4 &quot; &quot;</td>
</tr>
<tr>
<td>Electronic messages sent/day</td>
<td>8</td>
<td>10 &quot; &quot;</td>
</tr>
</tbody>
</table>

However, as discussed later, the behaviours of B/C managers and D managers as revealed by the questionnaire survey appeared to be similar on most issues, and indeed there was much more commonality than amongst similar groups in the other four companies.

Figure 4.24 Qualifications of Managers

<table>
<thead>
<tr>
<th>Interviewed Group</th>
<th>Questionnaire Group (not interviewed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HNCs Degrees</td>
<td>HNCs Degrees</td>
</tr>
<tr>
<td>HNDs</td>
<td>Higher Physics Degrees</td>
</tr>
<tr>
<td></td>
<td>Electrons.</td>
</tr>
<tr>
<td></td>
<td>Technology.</td>
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<tr>
<td>4</td>
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<tr>
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<td>3</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

Out of total of 17

Out of total of 21
In spite of the electronics environment in which managers had operated for years, personal computers, electronic mail and systems issues appeared in 40% of comments regarding major sources of change in the company over the last five years. Personal computers was one of two vectors (the other being organisational restructuring) most frequently quoted as producing substantial change. The speed of change of the technology, and the variability of the market were also often quoted sources of change.

Virtually all managers claimed their involvement with, and knowledge of systems and computers, had risen substantially over the recent past, as had their usage of electronic data bases. Information gathering, analysis and dissemination was also widely perceived as having increased. I.T., then, had become a fundamental and perhaps an essential component of the management method.

"I.T. helps me run my business better. We deliberately have a high spread and availability of PCs and terminals - to do a lot more analysis than we used to. The skill is to use the data well ... I go for the key indices and timeliness. Fast communication is also important - I can be a lot more responsive to problems - priorities can be changed quickly": C-6, a General Manager. He went on to say that I.T. allows a big business to be run like a small business - being in touch, and serving customers responsively and flexibly. C-6 was bothered that he was not well-versed in P.C. usage and was wondering whether personal use of a microcomputer would increase his personal effectiveness, particularly as his subordinates were more skilled than he was at data analysis and reformatting.

In Finance, C-14 felt that I.T. was "having a great effect on my role ... the many terminals allow instantaneous messaging world-wide, and common accounting systems, with consolidation of accounts at the touch of a button. Accounts are easily visible to H.Q."
Within one Technical department, C-2 said "My department is entirely dependent on I.T. Cheap, local computers makes access freely available to large numbers of staff".

It seemed that the power of the computer was increasingly being used in this technical function to create an even higher level of user-friendliness, and so extend the versatility and effectiveness of technical managers. The twin I.T. capabilities – fast data transaction and fast data analysis – were obviously key to current management thinking and behaviours. C-15, an Engineering manager, spoke of the high costs – of the order of £1,000s per hour – of certain production problems. Electronic mail allowed reference of such problems to technical experts anywhere in the world in minutes, or sometimes seconds. I.T. therefore allowed managers to have the advantage of virtually instantaneous conference with any other manager 'on the system'.

There obviously existed a complex interweaving of computing and management. A production engineer (C-3) described the indirect effects of computers, for instance, semiconductors could now only be designed with computer assistance (C.A.D.) due to complexity, and the absolute need for speed in creating new products. The point had been long passed where the option of not using C.A.D. was available.

The same scenario applied in the production process. C-7 told of a production control system for over 100 products passing through 20 or so separate processes but with each component needing a unique set of these processes, and with some reiterations. In addition, quality was at a premium and the capital cost for the high technology was high. The tracking of batches, and quality control, had become so complex that without computer-assisted-manufacturing (C.A.M.), would be impossible. However, C-7 was clear he was getting too much data - "no shortage of numbers ... formatting is the difficulty - which are the useful numbers? Management Services do not really understand what data are required. I have to try a system and alter it to suit".
A Planning manager (C-10) explained that he had had a PC on his desk for a year, with 3 others and 2 terminals available for his 8 staff. He thought he was spending 50% of his time actually on a terminal, although he claimed not to be knowledgeable or skilled in I.T. C-10 felt the power and speed of computer systems acted to accelerate the need for power and speed.

The picture was similar in the Marketing and Personnel functions: managers used and relied upon I.T. to provide fast data, and fast analysis. C-17 in Marketing thought he was spending 2.5 hours a day on a terminal: "I would be lost without it - I use a terminal for everything - I send 15 to 20 messages a day by electronic mail, and receive 20 to 25. It is the immediacy - the intelligence locally that counts". Another Marketing section had 5 PCs for 8 staff, all linked to the mainframe network. C-4: "The availability of intelligent work stations increases productivity in terms of analysis per person - weeks of analysis become hours". This manager had just completed a training programme for himself on two computer software packages: "Once I started using a PC I wanted to use it more - the danger is going into too much detail, too much data - though graphics help understanding a great deal".

Yet another Marketing manager (C-1): "In 1983 four managers had a PC on their desk - now virtually all managers and professionals have networked machines. I am on my machine 20 to 30 minutes each day - it's fun to use it. Tracking marketing plans is much easier on a PC and it is done better as well".

Another Marketing manager (C-8) did not have a PC, though he claimed there was a PC or terminal for every 1.5 staff in his group.

As in other functional areas, Personnel managers and staff used computer systems continually. C-5: "We are forced into usage because everything in Personnel is on the mainframe data base ... including staff performance appraisal (this computer facility is popular with managers as they can easily see who is
paid too much, or too little). A young (27) Personnel manager confirmed that "I.T. totally affects everything ... PCs used for spread sheets, graduate pay progression, electronic mail, and for accessing all personnel data, and personnel procedures".

Terminals and PCs were abundant in the Personnel area, and staff were obviously using them in a matter-of-fact way, calling up all manner of data and analyses.

3.2 Pace

Fifty per cent of returned questionnaires claimed that job pace was 20% higher than 5 years ago, and 61% thought time for reflection was down 10 to 20%, though there was no difference for these issues between managers highly involved in I.T., and those who were less so.

By observation, there was no doubt that the pace at 'Components' was high, and much higher than in the other four companies. Managers usually made clear that they wanted every second to count in the interviews: they were open, co-operative, but wasted little time on 'off the ball' subjects. The pressure and pace in the company was apparent at all times and in all situations - in telephone calls, in arrangements for meetings, and in managers' descriptions of their activities. C-15: "There are few routines - we have to react swiftly to production problems - we are committed to 'same-day response' (to wherever in the world the problem is) - it's a very fast pace". C-3: "One direct effect of I.T. is speed - because semiconductors can be sold only if we can make them fast ... The production details are sensed automatically. The mass of data in the system is more user-friendly, and I can home-in rapidly to specific questions ... I.T. is being used to make good decisions, fast. ... My pace is average at 'Components' and pace gets the work done". C-1: "I.T. exposes what needs to be done - faster. The pace is hectic and comes from the top in the States. We need to respond quickly to customers, and to product change". C-17: "If you do only one man's work you feel you are not doing a
'Components' job. You can do what you like but to get on you have to be self-motivated. ... Pace is faster than it has been".

These comments were typical. It seemed that throughout the company there was pressure to work quickly, to get things done, to avoid time-wasting. Hectic pace was endemic, with little time for reflection, and the increasing application of I.T. was perceived as speeding up activities even more. Several factors seemed to be associated with this apparent acceleration: virtual instantaneous interconnection of managers and technologists throughout the site, and throughout the world, improvement in timeliness of data (i.e. arriving in time to be useful) - quoted by more than half the surveyed managers - and the much greater use of computer data bases perceived by 75% of managers.

The production system had become increasingly complex in terms of the technology (wafer production, X-ray etching etc.), and in terms of the different sub-processes which could be combined several ways to produce the range of products. These complexities had reached a point years ago when product design, quality control, batch tracking, (etc.) could only be handled by computer. The discretion to choose to use a computer had disappeared - it had to be used. Similarly, in other functional areas, P.M.M. systems were unable to cope with the complexity, and the cost penalties of slow response. Again, computers and telecommunications were the sole option. I.T. applications, once installed, diminished slack time and slack resources: perceived (and probably actual) organisational pace increased.

3.3 Role Specification

No manager offered a printed organization chart, and while there appeared to be clarity in terms of business objectives, definition of roles tended to be loose. C-4 (Marketing) expressed this succinctly: "It's a very complicated organization - we have to keep reminding ourselves what we actually do". Proactivity was obviously a dominant element in the
culture: managers were expected to take initiatives. This freedom of action must, however, be set in the context of highly systematic reporting procedures, and company policies, both of which appeared to be known well and generally accepted and practised. (46% of surveyed managers claimed the number of rules and regulations in their job had increased).

Work fragmentation was high: managers frequently mentioned pace, changes of direction, responsiveness and flexibility. In addition there was encouragement for managers to consult freely within the site, and outside the site, on all kinds of issues.

All these factors contributed to virtually no role specifications: rather each role was self-defined, and changing often and rapidly, to deal with the contingent situation. Managers claimed their amount of 'routines' had not altered over recent years. Also, there was no difference perceived in routines changing, between the 'I.T.-involved' and the 'less-involved' groups. Generally managers had great problems with recall of how they used their time. (This was common in all five companies but was more pronounced in 'Components'), and while in most cases there were recurring activities, for instance, weekly meetings, the overwhelming impression was of reaction to events but in a proactive way. In other words, once the stimulus of a problem, or opportunity, had occurred, the manager had high proactive freedom to deal with it.

C-14 (Finance): "There are some routines - say 1.5 hours a day, but the rest is ad hoc ... planning of my day-by-day work is appalling ... the dynamism of the company needs people like me to be responsive". C-2 (Technical): "20% of my day is routine but most of my work is reactive. At the moment I am dealing with four jobs simultaneously - I am addicted to this feeling but at times I think it's hell. The company climate is hectic - thinking is in your own time". C-15 (Technical): "There are no routines to a wide range of my responsibilities - we have to react quickly - I would not want a pattern for my work".
More routines were quoted in the Production area - possibly because operations were linked with batch tracking. However, even there, unplanned activities predominated. C-7 (Production): "Not much of my time is formally structured - perhaps 4/5 hours a week is predictable time. The rest is highly fractionated - chunks of about one hour - but often much shorter. In practice I deal with priorities as they come up - I can't say there are a hard and fast set of guidelines". And again: "I don't have many routine tasks ... very disorganised ... I decide what I look at next". C-10 in Production).

In Marketing this same picture emerged - but more so. C-8: "It's pandamonium from 7am to 9pm - fire-fighting most of the day, mostly in 10 minute elements". A Personnel manager echoed a similar story: "My job is not at all routine. not enough routine, - a stream of brief events, breaking up the day. I'm bombarded with questions - the number of subjects I handle every day is very large - it's impossible to get 15 minutes of uninterrupted time!" (C-5 Personnel).

Clearly, managers in 'Components' were using electronic mail to a much greater extent than five years before, and this conferred greater transparency to the organisation. Throughout every day streams of messages were being received by each manager - prompting action, and usually, the dispatch of more messages. (This will be dealt with later under Communications). The message stream informed and interrogated the manager, thus stimulating, and restimulating action. Although the culture endorsed proactivity, the apparent effect of electronic messaging was to produce higher reactivity, the 'urgency' of priorities tending to take preference over 'importance'. The impression was that electronic mail, while valued by managers, was probably tending to increase fragmentation, and pace, and to decrease role specificity.

3.4 Planning

Two thirds of managers felt the planning elements in their roles
had increased and that they gave more emphasis to strategy, as distinct from short term tactics. The time ahead on which managers focussed was also said to be greater than it was five years before.

Managers were required to make estimates of business indices at prescribed future periods - and this data was integrated to form product group, country and world-wide plans. Here, the computer system was tightening disciplines of timing, format, and requirements for action, on managers, in terms of the formal planning protocols.

However, within their informal (and as previously described, pacey, fragmented and unroutine) roles, most managers appeared to give a low priority to planning, and to regret that. C-6 (General Manager): "I am dissatisfied in the area of planning - it's related to how the company operates - a bit overboard on short timescale issues. It takes willpower to get quiet for a day - I just don't spend enough time on reflection". C-7 (Production): "Most of the impact of I.T. systems is in shorter term - fascinating data is produced, and can be seductive. I.T. tends to focus me on immediate issues. But I do make time for reflection". C-11 (Marketing): "I'm not doing enough planning - that tends to be a company norm - to act on tactics - and this is worse in marketing". C-8 (Marketing): "Most of the time I'm thinking - how can I survive the day? Crises generate crises. Having a planning background is very important now". C-9 (Data Processing): "I do too much fire-fighting - I never have enough time to thoroughly plan - my reflection is usually sitting in an aeroplane. The pace is too fast - planning is always pushed out by immediate needs ... The system sets times when specific data is required - and system timings are critical across the world. I.T. pushes people toward dealing with the immediate". And in Personnel too: "I don't do much planning because of the amount of change we face - we are skilled at responsiveness - but I wish I could plan more!" (C-13).

It would seem from this that I.T. was having two opposed
effects. Formal planning was disciplined by virtue of the computer driven system, but individual managers appeared to be more focussed by I.T. on the immediate, with a consequent weakening of personal informal planning.

3.5 Boundaries

Boundaries, both vertical and functional, at 'Components', appeared to be insubstantial and easily crossed. The company practised a 'single status' policy in conditions of employment and this was expressed in common arrangements for office layouts, car parking and refectory. No organisation charts were in evidence, and job titles generally contained no indicator of status - indeed to an outsider it was difficult to classify managers either in status or in function from job titles. There appeared to be a tacit understanding that all functions contributed to the well-being, and success of the company. Further, integration between functions seemed to be necessary for success. Thus managers communicated freely with whoever they believed to be useful to the situation. The culture traditionally encouraged boundary crossing. (This is discussed further under Communication, later).

The widespread use of electronic mail, and of cross-functional data bases, augmented boundary crossing and the insubstantiality of boundaries.

3.6 Summary

In spite of the company having a deep and long familiarity with electronics and computing, the use of I.T., especially personal computers, was regarded as a major source of change. Information technology and management were strongly interwoven, with electric messaging, and computer analysis and display, being commonplace parts of managers' jobs. Managers had few routines and claimed that the use of I.T. was reducing role specification and increasing work pace. Informal, personal planning was reduced because of the continuous prompting via I.T. However,
the technology enhanced the disciplines of formal, company planning.

As in the other companies the existing culture strongly conditioned I.T. effects on managers' work.

4. Managers and People

4.1 Numbers of People

It proved impossible to link changes in numbers of staff specifically to use of I.T. Obtaining historical data on numbers employed, on turnover and profit and loss, was not possible. Further, market fluctuations and the rapidity of product and process change meant that internal restructuring was a continuing process. Thus numbers of people in particular sections were associated much more with designed alterations of business practice (for instance, reporting patterns or methods of production), than to applications of I.T.

Spans of responsibility are shown in Figure 4.25.

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<thead>
<tr>
<th>Tier</th>
<th>Numbers of Staff Reporting Directly to Manager</th>
<th>Numbers of Staff Manager Responsible for</th>
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<tr>
<td></td>
<td>Mean</td>
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<td>2</td>
<td>5.6</td>
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* 80% of managers in this range.

Both Tier 2 and Tier 3 managers reported that numbers of people reporting to their first line supervisors had risen over the previous five years.
Three interviewed managers talked of staff reductions because of I.T. applications. C-17 (Marketing): "We want to become more effective by reducing head-count; people and asset effectiveness is prime - and that means using more I.T.". C-8 (Marketing): "In 1969 there was an order entry group of 25 staff - taking telephoned orders. A computer system was put in allowing fast interrogation from outside the company - a much more efficient interface with customers - and the entry group has completely disappeared". Other managers saw I.T. as having great potential for increase in productivity, but for the purpose of increasing output with the same staff, rather than for decreasing staff. C-6 (General Manager): "I.T. is being used more because of the foresight amongst key people (in the U.S.A.) to see productivity as linked with technological tools for staff. We push personal effectiveness by having a high spread and availability of PCs so that we can do much more analysis".

The assumption running through most interviews was that I.T. had vast potential for increasing the success of the company - particularly in fast analysis, and fast communication, and should be used wherever possible. This 'added value' theme suggested the company was on a later stage of the implementation curve in which staff effectiveness was the predominant issue, rather than staff reduction.

4.2 Skills of People

'Components' is a highly technological company: its managers are well qualified, usually science or technologically experienced and there are many technical staff. Three quarters of the surveyed group of managers felt that the number of professionals and skilled people amongst their subordinates had increased over the preceding five years. The impression frequently given was of an increasingly complex business, technically, economically and organizationally. The key orientation, which continually emerged, was data - acquisition, analysis and dissemination. (This is dealt with later under
Not surprisingly then, discussion of skills of subordinates was often focussed on this same theme. Although, naturally, skills in functional areas, that is, in Personnel, Finance, Marketing and Production (etc.) were also prime. C-6 (A General Manager) was obviously concerned about the development of his subordinates and the balance between business needs and people needs. He was bothered that he himself was not well-skilled in P.C. use and data management, and trying to decide whether he should be more skilled. Here was a case where subordinates were more skilled at accessing and analysing business data than their manager.

C-14 (Finance): "Although we have reduced the number of people in the section, we have increased number of qualified accountants ... all the mechanical processing is by machine - the interpretation is all-important - and needs highly skilled staff ... My concept of our system is a central bucket of data able to be manipulated to the shape required, but because of the ease of access, we are less and less likely to have the required data in our heads. My staff are therefore using their brains more for dealing in concepts and analysis". And C-2 (Technical): "People are still improving in terms of experience and qualifications". He went on to explain that skills were changing, as increased computer power became available, allowing engineers to work in higher level language and so to focus more on the problem than on the process of solution.

In Production, C-3, responsible for 136 people, said that his total staff had reduced due to productivity gains (because of technological improvement) and that his supervisors were now less managers of people and more managers of the total situation (meaning equipment, quality, cost and people). C-7, also in Production, confirmed that numbers of unskilled, and manually skilled, staff were decreasing due to automation. The ubiquity of I.T. and its effects was evident in Production Planning where 9 staff (4 professionals, 4 skilled clerical, plus 1 unskilled clerk) used 4 PCs and 2 other terminals, in a continuing stream of interactive analyses. The manager (C-10) and his subordinate
were spending 30 to 50% of their time at the terminals. For all these people it was clear that conceptual and system skills, in relation to data, (knowing what programs were available, how to access programs and related data, and being skilled in understanding revealed information) were of high importance. This pattern of work was apparent in several other sections and was characterised by managerial and non-managerial roles being similar, and subordinates having high access to data via terminals. Indeed, 75% of managers in the study thought the access of their immediate subordinates to information available to themselves had increased over recent years. (There was no difference between 'I.T. involved', and 'less involved' managers on this point).

Another theme was the difficulty in obtaining sufficient qualified and skilled personnel (50% of managers reported this).

A systems manager (C-9) explained that there was a continual upward movement in terms of knowledge and skills; for instance, programmers were decreasing (due to use of higher level languages), but business systems staff were increasing. Work was proceeding on developing 'Intelligent Knowledge Based Systems' (I.K.B.S.) which required very high skills in comprehending the reality of managerial and professional work. He felt that managers in the company, in spite of the profusion of electronics, were not sufficiently knowledgeable on information science, and systems, and that there was too little understanding of the effects of I.T. on managers.

4.3 Training

Clearly the pace of technological change forced an inherent learning posture on most professional and technical staff. Almost always, when training was mentioned by managers, it implied a technical context. For instance, C-2, a manager in a Technical section: "The company has a long range strategy for continuously retraining staff - the average staff member in any department spends three or four weeks a year on technical
courses". There was also a widespread training issue in relation to PCs, typified by comments from C-6 (a General Manager): "I have to be sure my people are competent on PCs and in systems understanding, although I myself may be the last of the wave of non-systems-knowledgeable managers (in our company)". Managers varied widely in their own abilities to handle PCs and computer packages, and the less able were wondering if their managerial effectiveness would actually be enhanced by such skills.

Training was rarely spontaneously mentioned by managers; but the impression was given that management training and development was not a priority. Indeed, the whole canvas of data science and management seemed not to have received deep attention. To specific questions, managers often said they themselves had had little exposure to management courses.

There appeared to be a vigorous 'training-by-doing' environment, for all levels of staff. For instance, C-7 (Production): "I am continuously looking at the evolution of my people, and how I can organise to develop people - for instance by job rotation". Job competence was obviously linked with other factors such as salary and promotion. Reviews of staff were systematic, and those within the bottom quartile of the range were counselled to improve, or sometimes to alter their career routes. Again, these underlying structures, putting emphasis on performance, appeared to be motivating staff to work hard for long hours, and to encourage self-help in discovering how to get things done.

4.4 Management of People

While each of the companies studied had a unique culture, that at 'Components' seemed to be much 'stronger' and ubiquitous: staff at all levels expressed similar views of "how things are done around here". Verbal expressions of company styles and policy, and the behaviours of managers (in interviews and from observation), and of secretaries, technicians, switchboard operators and receptionists, together created an image of a
coherent and self-assertive culture. Many influences obviously had contributed, and were still contributing to, the nature of this culture; one of them being the fast moving technology of its products. It has to be emphasised that even though the products of 'Integral' and 'Components' were similar, their cultures were totally dissimilar.

Part of this sturdy culture at 'Components' appeared to be a well thought out policy of people management. Naturally, the high technology ambience required staff well educated in the relevant technologies, but quality in educational requirement, and emphasis on careful selection was evident throughout the company. Young graduates were expected to engage in real issues almost from their day of appointment, - all presented short briefings to the M.D. and Personnel Director on their current work within weeks of starting with the company. Youth was apparent throughout the organisation: the M.D. and Personnel Director were under 40 and the mean age of interviewed managers was 37. The lay-off in January 1985 was carefully designed to reduce the age profile - nearly everyone who left was over 45 (according to C-12).

The key emphasis was on hard work and commitment, and this translated into the fast pace, previously discussed, and the continual drive to achieve maximum output for minimum input. A disciplined staff appraisal system was used in which managers ranked all their staff. Feedback to staff also appeared to be well developed - thus there was a widespread understanding of what had to be done to earn high salaries, and to gain promotion. The company practiced a single status policy, with low visibility or hierarchy, similar office space and furniture for all staff: 'first names', and informality abounded. The summation of all these factors created an organization completely different from the other four companies studied. While much of this ambience was 'designed-in' by adhering to policies presumably originating in the U.S. (and probably derived from the historical themes of the parent company), the interviewed managers ostensibly had internalised these ideas and
their management style was a derivative thereof.

A question arises: how was the increasing I.T. usage altering the management of people?

Although some reduction of staff related to I.T. was quoted, and while head-count and productivity were obviously vital, most managers had the same numbers of staff as five years previously, while the proportion of professional and skilled staff had generally risen.

Technically well-qualified managers were thus managing technically well-qualified, or technically skilled, personnel. The greater spread of terminals, PCs and access to data, meant these skilled subordinates had opportunities to use equipment, to interrogate data bases, and to use electronic mail in the same manner as their managers - and indeed in some cases more than their managers.

Thus, the impression was that the differences between managers and non-managers (already designed-in to be low in visibility) were reducing, due to I.T., in ways which were central to management, i.e. in relation to information access and control.

4.5 Summary

It was difficult to associate specifically the use of I.T. with staff reductions, though it was widely believed I.T. was pushing up productivity. The proportion of professional, highly qualified and highly skilled staff was rising and the differences between management and non-management roles were decreasing. Technical training was sound with a strong emphasis on personal commitment, hard work and continuous learning. Management training appeared not to be given such a high priority, though the corporate style and practice of 'management of people' was powerfully transmitted and reinforced amongst managers.
5. MANAGERS AND COMMUNICATION

With the abundance of facilities both for electronic processing of data, and for its transmission by e-mail, and the cultural disposition toward rich interactions between 'relevant people' communication might well be considered the quintessential feature of management at 'Components'.

It is important to emphasise again the differences of communication content (hardness - softness), and of method (systematic I.T. based, and oral), discussed in Chapter Two. 'Components' is highly sophisticated in computer systems of all kinds, and in all functions - and much more so than the other four companies studied. The impression was given that computer based systems had been used and continuously modified over decades, with high commitment to these developments throughout management. Paper-based 'transaction processing' had largely disappeared many years previously: I.T. has become an internalised component of the total organizational process. Given the senior-level commitment to I.T., and the cultural norms of pace, responsiveness, proactivity, informality, hard work and achievement, and the electronic facilities, there was a universal zeal for communication and information management.

5.1 Structural Issues

The culture of the organization encouraged informal contact with relevant persons irrespective of either functional boundaries or hierarchy. Organizational structure appeared to be dynamic and responsive to need. Again, the flexibility of I.T. systems, given the rich distribution of access via terminals, appeared to reinforce this flexibility. In fact I.T. increased the range of data sources and personal consultation for managers and thus the flexibility and responsiveness of the total system. Managers found delineation of their communication patterns difficult - more so than in the other companies - the reactivity to e-mail, the pace and the 'open access' culture all undoubtedly contributed to this uncertainty.
Thus the extensive electronics system further increased the ease of data flow and data access, and this organizational transparency - a feature commented upon by several managers. There was a degree of threat in this level of openness: senior managers were informed of issues as early as were section managers. Not only were specific functional indices exposed (for instance, accounting measures) to senior levels, but this information stimulated interrogation of both the computer data base and other managers. E-mail allowed this rapid interrogation and created the expectation of fast response. An example of this mentioned by several managers was the world-wide accounting system using international index standards, enabling a range of monthly accounting measures for all plants to be available at head office (in the U.S.), and simultaneously to each relevant manager in each plant. This simultaneous availability of data, plus virtually instantaneous e-mail, allowed management analysis and understanding of the data to be considerably enhanced.

Another similar example was the systematic planning and budgeting procedures which required each manager to state financial, product and people targets three months, one year and three years ahead. Once on the electronic data base, senior managers can explore these projections in detail, and once again, using e-mail, can 'discuss' issues with section managers. Some managers had PCs at home so they could communicate with the corporation, world-wide, and managers frequently spoke of being in touch with the system (and the system with them) wherever they were - for instance, on overseas visits. But there were dysfunctional effects of this ease of communication, as many managers implied. CQ-14 (Technical): "Ease of exchange of technical information ensures better synergy among our world-wide technical teams (e.g. less duplication of effort). However, the result of this is that technical managers then need to spend more time digesting and analysing the vast quantities of data which they now can access". CQ-5 (Personnel): "Since 1980 the biggest change in the company has been the speed of
communication and the volume of information that can be transmitted easily. The volume of information is impossible to cope with - e-mail has to be dealt with outside normal day. Currently the ability to communicate quickly is being used largely to let everyone know everything - and can be counter-productive".

C-6 (General Manager): "Our levels of communication have increased and that's for the better. It is difficult to feel close to a guy in Taiwan, but it helps if you are messaging with him electronically ... because of widespread access to data, the company is one huge network and corporate awareness is higher". Managers did occasionally complain that other people were not responsive to e-mail, and therefore they used the 'phone. C-5 (Personnel): "The benefits of instantaneous messaging are large - providing people are reading their mail. The disadvantage is the excess of communication - most managers find it difficult to cope with the volume of information. Everybody gets copies - which tends to get more people involved than needs to be - there is also an unreasonable expectation of fast response".

I.T. then, was probably not altering the formal structures at 'Components', but was enhancing the extant dynamism of communications, and communication patterns.

5.2 Data Issues

In interviews managers talked of information and communication issues more than of any other subject. From the questionnaires, three quarters of managers thought their involvement in information gathering, analysis and dissemination had increased in recent years, and 67% felt their time chasing information had increased. This is another example of the 'positive feedback' of I.T. systems - although access is reputed to be faster and more widespread, that itself appears to generate more information access problems. This is associated with amounts of information available - seen to have increased by 95% of managers (70% said paperwork had increased).
Data issues which surfaced commonly were information quantity and relevance. As discussed in Chapter Two, all data contain information: it is the art of analysis, reformatting and display which reveals it. With increasing adroit electronic systems managers can restructure data to reveal arrays of relationships - for instance of product clusters, prices, costs and sales by geographic regions. But once again, what constituted optimum advantage? This question came up repeatedly.

C-6: "Shall we ever get the data we want? At present I am not getting the data I want, but given time I could improve it - but the business is about analysis. It is formatting that counts. Lots of data are on the main frame and are bureaucratically difficult to access - we are spending much system design time on converting material from main frame to P.C. usage. We probably see too much data - we have to learn to trim data dependent on what is currently important. The danger is that you ask for more data and inappropriate data". (Managers often used 'data' and 'information' interchangeably). C-14 (Finance): "I don't get all the data I need - I need more in each of the systems - I want the ultimate in flexible data base - to interrogate how and when I want ..."

C-15 (Technical): "There is an awful lot of stuff - 60% of the data I use is on-line - it's essential to keep a 'file on files'. I personally store material electronically rather than on paper". C-3 (Production): "I'm getting too much data - computers spew out lots of numbers - but which are useful? Formatting is the difficulty - Management Services (who design the systems) do not really understand what numbers are required - you have to try a system and tailor it to suit. I don't have enough knowledge of systems and their potential - we don't have our own systems or software man (in my unit) - and a crack company systems man is incomprehensible". C-10 (Production): "The amount of data has probably doubled over the last two years - a lot of redundancy and a huge amount of paper. Sometimes poor layouts of data - very little yet based on variances. The
systems designers have more power than the systems users!". C-1 (Marketing): "The biggest percentage of my time is spent thinking about data. I am calling for more and more data; in the past it was too difficult to get because it was on paper - now with PCs and friendly packages it is much easier. It's a bit of a drug really - PCs are fascinating - there is more analysis - but we may lose sight of the objectives. Timeliness is not improving because of data quantity". (This 'self-induced' information overload for managers was noted by O'REILLY (1980).)

This theme of too much data, and the problem of deciding the relevance, and utility, of information ran through many interviews, and was often coupled with two observations. Firstly that the manager himself was not informed enough on systems design, and secondly, that systems design had not sufficiently taken into account the users' needs.

Timeliness was claimed to have improved by many managers, though timeliness, data and quantity, relevance, and ease of access are interactive in a complex way, and not separated clearly in the perceptions of managers. C-1 (Marketing): "Data timeliness is not improving due to more material being accessible".

Another effect of I.T. is the creation of tight system time disciplines (found in the other companies also) - that is, inputs to the system are required at specific dates. This time discipline imposes itself on the organization generally and anonymously, and managers felt, and expressed, their need to stay within this time synchronisation.

Data bases were much quoted by managers in their descriptions of roles - 95% of managers claimed that their use of data bases had increased. Associated with this was widely increased data access by subordinates and a general reduction in barriers to gaining information.

The overwhelming implication of managers' statements was that
the value of information had increased due to I.T. Speed of transmission, ease of access, reliability, and analytical and reformatting speed and power, were quoted continuously. Often the impression was given that the directions and pace of developments could only have been maintained because of the spread, and power, of the electronics technology. C-8 (Marketing): "We could only have gone to a European marketing structure with our I.T. capability - our competitors have had severe communication problems". Similar sentiment was expressed in product design, in Manufacturing, in Finance and in Personnel, in relation to their own functional developments.

That there were dysfunctional implications has been catalogued above - in increased paperwork, in sometimes frenetic responsiveness, in focus on immediate concerns, but the net effect expressed by all managers was positive.

5.3 Oral Communication

As in the other four companies, managers at 'Components' were involved in much oral transaction - in the whole range of person-to-person communication - counselling, briefing, meetings, and conversation. Indeed, the informal and 'team-like' relationships with both subordinates and superordinates were more characteristic of a research institution, than a commercial company. Seventy per cent of managers felt their time talking with immediate subordinates and with more senior managers had increased in recent years, and while this may have been wishful thinking, certainly there was no evidence that as I.T. systems extended, oral communication contracted.

C-10 (Technical): "I talk to my boss six or seven times a day - the approach could be initiated by either of us - good, open relationship. I need to keep him in the picture to avoid surprises - so that he can prepare actions at a higher level". C-4 (Marketing): "We have weekly meetingss of our on-site group to share information and agree directions. Sometimes I think we all talk too much together - 'facetime'. I spend a lot of time
with branch managers - informal - open door policy. I also talk with branch heads of engineering, production planning and product development - at my level. Informally I chat with my boss two or three times a day - he's wanting info for his managers above". C-13 (Personnel): "Any employee can have access to me - sometimes through their manager but 'officially' any one can walk through the door. I see ten to twelve people each day - they talk about anything. I am upward responsible to the Personnel Director and am constantly in and out of the office - sharing information and planning activities. He is open and supportive - people are accessible here". The Personnel Director confirmed this and said in turn that he sees his M.D. twice a day. "The M.D. is happy for me to go to him on anything - he wants to be 'surprise-free'. There is no conditioning in 'Components' restraining managers from referring up for advice".

The summation of managers' comments portrayed a highly oral environment, informal, team-like, seemingly based on an underlying conviction that informing and being informed was a continuing necessity for success, personal and organizational.

5.4 Summary

The generic character of I.T. appears to reinforce the rich and free-flowing nature of communication at 'Components', - perhaps the quintessential feature of the culture there.

Managers gave high priority to information management: in fact issues of data acquisition, analysis and comprehension dominated their roles. Generally, the use of I.T. appeared to increase the value of information, though the amount of data produced dysfunctional difficulties of relevancy and priority.

Use of I.T. increases the range and informality of personal contacts and decreases the constraints of functional boundaries and hierarchy. At 'Components' this has long been acceptable and does not seem to produce the tensions for managers found in
the other companies. Oral communications continue to be essential and prolific - in spite of the extent of I.T.-based interactions.

6. MANAGERS AND DECISION MAKING

6.1 Decision Issues

As in all the companies, managers at 'Components' found the arena of decision making the most difficult to recall, and to delineate. There was little spontaneous reference to the subject, in contradiction to the extemporaneous flows of comment on communication. There was, however, a high consensus (86%) amongst the surveyed group that taking decisions had increased in complexity, though managers commonly gave the impression that everything had become more complicated. This was partly related to the multiple reporting patterns, particularly the 'nestling boxes' structure (U.K., in Europe, in World), and partly the 'communicate with everyone' mode.

As discussed earlier, the corporation had a well understood strategic plan, and disciplined forward budgeting constructed by every manager and then integrated into a whole. It was clear that these two processes, top-down strategy and bottom-up budgeting (and planning), created a stabilizing framework containing the widespread and favoured initiative taking. Also there appeared to be definite guidelines for decision authority (although 61% of managers thought their authority to take decisions had risen). C-6 (General Manager): "Planning in detail is fairly automated (by I.T.) - I should be thinking about 1986/7 (a year ahead) most of the time. We also have a long range system 5/6 years ahead - which is difficult but mandatory because of the lead time to bring in new designs and produce them". C-14 (Finance): "I have to refer up to the Personnel Director, and possibly to the M.D. on hiring people, and all capital decisions over £1,000 (except for PCs and furniture) have to be decided at corporation H.Q. (in the
C-11 (Marketing): "We track our business very carefully by computer - what we win and lose - every sale is negotiable and I have authority to change product prices. I mostly don't refer decisions upward".

Everywhere pace was manifest. The combination of volatile market, speed of technological development and the fast electronic transaction capability combined to force rapid decisions. In fact, the culture acclaimed rapid decision making: responsiveness was regarded as a prime favourable attribute. As in other areas, it appeared that the use and availability of I.T. had paradoxical and sometimes opposite effects. The ability to consult widely and often, and to access powerful data bases rapidly, allowed a higher level of 'organizational intelligence' to be applied to situations. Examples were quoted of solutions to problems being available by fast access to 'expert' advice, thousands of miles away - and it was obvious from observation that this process was continuous and widely used. On the other hand, the mass of information 'on tap' to managers was frequently mentioned as confusing or overwhelming, and complexing the decision process. Further, incoming streams of messages via e-mail focussed managers onto immediate issues - probably to the detriment of taking longer term views. (In spite of this, managers felt their planning had increased and their time horizon had extended).

The personal computer was widely identified as a new systems facilitator - allowing ease of access and use of programs and data, in contrast to the bureaucracy and relative slowness of response of the main-frame system. Culturally favoured features of speed and responsiveness were enhanced by the PCs. One senior manager thought decision making "was quite sloppy - not far from careless. The technology may be driving us to worse decision making - there is not much introspection - not much probing - but a lot of speed. Actually the decision tight rope is not as narrow as we make out. We make fun of staid
industries, but the high technology industry is not universally manned by brilliant managers, ... high tech specialists are often thoughtless and in too much of a hurry”.

This man's comments - he was interviewed quite late in the research - well summarised the decision making culture at 'Components'. I.T. certainly conferred advantages, but as with many activities, the crucial feature was balance. The technical merits of speed, analysis and synthesis had to be balanced by managerial competencies, and time to pursue and use them.

Summary

In contrast to 'Integral' there was a strong and well-understood decision framework at 'Components' guiding managers both in terms of content and timing. I.T. appeared to be enhancing decision making, though the continuous frenetic and responsive pace also conferred disadvantages in shortening the time focus of managers. The frequently mentioned 'data overload' with its inherent problems of priority and relevance, is certainly making decision making more complex.

7. SUMMARY OF I.T. EFFECTS

In every way, 'Components' is conspicuously different from the other companies. Its business has always been based on electronics technology and systems, and its culture is innovatory. The use of I.T. is highly developed and is commonplace in all functions - though managers still regard it as a key source of change. Throughout, managers are deeply involved in I.T.-based information management and I.T.-based communication - and much more so than in the other four companies. Management and I.T. have become inextricably interwoven.

The basic character of the work of managers, already treated several times in this thesis, are found in this company also. Inescapably, whatever the culture, jobs of managers are highly
fragmented, unroutine and oral. If anything I.T. is reinforcing these fundamentals at 'Components'.

As has been found elsewhere, the technology may produce opposing implications. For instance the ubiquity of access, and continual prompting of managers via terminals, pushes them towards reaction to short term, tactical issues. On the other hand, the computer managed mid-term planning and budgeting regime extends time focus. Interestingly, managers have a high acceptance of this tight and rather anonymous planning mechanism. Also the node-to-relevant-node communication engendered by I.T. stimulates initiative taking, and weakens designatory structures. Thus I.T., in this company, is enhancing both management reactivity, and proactivity. Reaction is prompted by I.T. but once stimulated managers have wide scope for initiatives using I.T.

The 'productivity vector' of I.T. is well understood amongst managers who are constantly pressing for improved performance. The number of staff for a given output is reducing, though in this company the 'added-value' orientation regarding the technology is highly developed. Skills of people are commonly believed to be increasing and changing, with managers and non-managers jobs becoming less different.

The abundance of I.T. facilities allows rapid communication throughout the site, and throughout the world. Thus not only is transparency increased within the local management group (as in the other companies), in 'Components' that transparency extends throughout the corporation. As found elsewhere, increase in transparency tends to cause feelings of vulnerability amongst managers.

In spite of the richness of technical communication, oral transactions continue unabated. In fact, as 'team' relationships are the norm at 'Components', and as status and functional inhibitions are not significant (partly because of I.T.), oral communication is even more manifest than in the other companies.
Decision making was increasingly aided by, indeed, part of the I.T.-driven information system. While information being easily and quickly available confers advantages to the decision processes, the I.T.-induced data overload produces problems of relevance, and at times, confusion, for managers.

Each of the companies is, then, on its own "I.T. trajectory", partially determined by the inherent qualities of the technology, but also determined in a major way by the particular organizational cultures. 'Fashion' is patently in the very early stages of I.T. use; 'Components', on the other hand, has had a long experience of sophisticated computer-driven information systems, and telecommunications. The other three companies fall between. But it would be over-simplistic to see the five companies lying on a smooth continuum representing their degree of I.T. sophistication. Rather, as a consequence of a multitude of pressures, internal and external, each had arrived at its own unique I.T. scenario at the time of this study. Each faces its own set of problems and opportunities, though, as the analysis in the next chapter will show, there are commonalities. There is much to be learnt from each case, not least, that with extremely high levels of I.T. as at 'Components', there are disfunctional effects as the information overload on managers increases their problems of data priority and relevance.
"Managers reporting to me are more numerate - 'people orientated' managers may be decreasing and 'data oriented' managers may be increasing."  Director - Fashion

"IT is affecting my job greatly - the biggest problem is understanding the info the computer gives me - it's usually too much ... we do not yet understand the system."  Production Manager - Integral
CHAPTER FIVE : ANALYSIS

1. INTRODUCTION

The objective of this research is to improve understanding of the implications for managers of increasing diffusion and use of information technology in their companies. The analysis which follows is thematic, drawing ideas and material from across the five companies, and integrating research findings with the key literature.

There are three sections. Firstly an introduction; then the implementation of I.T. in the companies is examined, especially in relation to managers; in the third section the implications for managers are characterised.

In spite of the five companies having many similarities, their uniqueness is striking. In every respect - in attitudes, structures and practices - each company has its own, very different, story. And, importantly for this research, each company has its own history of I.T. in terms of pace of introduction, choice of equipment, applications, and impact on people and processes. Each company is, it seems, on its own I.T. 'trajectory'.

'Fashion' is the least developed in I.T. terms, and in shop floor mechanisation. It is regarded as being in the very early stages of I.T. development with only slight effects on management work. Even though 'Integral' is in electronics, and part of a giant multi-national, the use of I.T. for management purposes is not well developed. There, I.T. impact on managers is slight-to-medium.

'Engineering' and 'Hardwear', both parts of multi-nationals, and with a long history of computing practices, have the greatest similarities. In both, I.T. is gathering momentum as a major change force, and effects on managers are distinct and widespread.
'Components' is a different company from the others in all respects. It has long experience of sophisticated computer-driven information management and a culture which gives great weight to adaptation and initiative taking. This organization is by far the most affected by I.T. and may give the best indication of future directions of I.T. implications for other companies.

Historically, technology has been predominantly associated with physical products, and their production (see MACDONALD et al, 1983). Office activities, and specifically, management arenas have in contrast, been largely non-technological in concept and in practice. Although pre-cursors to I.T. have been infiltrating office settings for decades, it is only recently that management contexts and activities have been influenced substantially.

While the chosen companies are all in the manufacturing sector, the managers in this study are almost always in office settings, and in non-manufacturing functions such as accounting, marketing or personnel. Some production, and factory, managers are included, and naturally their work is closely associated with the shop floor. However, this research is primarily about managers in office settings.

Although each company is different the analysis shows that a coherent thesis about the diffusion of I.T. and its effects on managers is possible. It is presented in the rest of this chapter.

2. IMPLEMENTATION OF INFORMATION TECHNOLOGY

Each company had its own unique history of precursors to I.T. All had several decades of experience of telephones, telex, punched card data processing and shop floor mechanisation. And except at 'Fashion', computing practices stretched back twenty to thirty years. Forms of 'work-study' and 'organization and
methods' (0 and M), had also been used in each company. There was then, no tabula rasa.

The company uniqueness naturally extended to all aspects of culture, structure and processes. In spite of the five organizations having common features - they are all in manufacturing, medium-to-large, situated in the same geographical area, and have similar functional activities - their differences are the more striking. Such dissimilarities had been expected between 'Fashion', the garments company, and the four engineering businesses, and these were certainly revealed. But there are major contrasts between all companies, and especially (and significantly) between the two electronic companies.

It was also plain that the range of knowledge and experience of I.T., and enthusiasm for its application was wide amongst managers and professionals. As shown in Chapter Two I.T. has many forms in terms of hardware, software and usage, and a user-manager usually knew only those applications specific to his work context. The sample of managers interviewed was based on some involvement in I.T., and yet even these people were seldom knowledgeable on systems and computers. The lack of awareness of the advantages of using I.T. on the part of British managers reported (for instance) by NORTHCOIT and ROGERS (1982), still seems to apply. Senior managers in the Management-Information-Systems (M.I.S.) function, although expert and enthusiastic about I.T.-driven systems, rarely had a complete company overview. Certainly, the common nature of electronic digital technology underlies and integrates diverse systems such as automation, robotics, computing and telecommunication. But the plurality of I.T. is also dominant. While the inherent characteristics of I.T. discussed in Chapter Two are important in determining its diffusion and use, the specific choices of equipment, software and mode of implementation are also key.
2.1 Contention, but evolution

GOOET (1985) argues that the current transition crisis in societies results from the opposition between technological and economic driving forces for change, and inertial forces of social behaviour and structure for maintaining the status quo. This usefully describes what was found in this research. However, it would be simplistic to portray these tensions as linear. Rather, in each company there exists a multi-directional web of interests, which is itself dynamic. As new technologically-based activities are introduced, the accumulating experience changes the knowledge base, and the enthusiasms of individuals. Technological and economic parameters of I.T. - vital ingredients in the unfolding - are also changing swiftly. These are altering the gross technical and economic disposition of I.T.-based systems compared with existing pre-I.T. arrangements. But they are, at the same time, changing the relative attractiveness of particular I.T. hardware and/or software, as compared with others.

In each segment of the companies, therefore, the state of I.T. implementation is evolving as the result of contention between several technical, economic and contextual factors, which may be grouped as:

a. the inherent technical characteristics of I.T. (discussed in Chapter Two) such as speed of operation, which result in actual or perceived economic advantages;

b. the relative technical and economic choices between competing I.T. alternatives.

Both these are primarily promoted by, and argued between, I.T. experts, and

c. the unique company, functional and hierarchical contexts, represented by the wide range of managers, supervisors, professionals, and staff; and various levels of sophistication of existing systems.
There are no discontinuities: rather the evidence everywhere is of gradualism as successive changes are made. However, it is clear that since about 1980 there has been an acceleration both in the spread of technology - hardware and software - and in the realisation amongst managers of its potential for competitive advantages.

As suggested earlier two schools of thought on I.T. implementation are articulated in the literature. The 'rationalists' deriving from the TAYLOR tradition, see I.T. as a continuing and inevitable substitution of machines for people. Indeed, amongst this group, the pessimists believe the process will unerringly result in a decrease in jobs, degradation of work, and an increase in social controls. (BRAVERMAN, 1974; BARRON and CURNOW, 1979; JENKINS and SHERMAN, 1979). The second school takes a contingency approach, seeing the effects of I.T. as dependent on context. (LAND, 1984; BESSANT and GRUNT, 1985).

What the research here indicates is that there is a certain determinism inherent in the characteristics of the technologies which are driving organizations and their managements in identifiable directions. But in the shorter run the patterns of implementation are the result of the interplay between many actors, and are conditioned strongly by context. (As has been found elsewhere, see for instance WILKINSON, 1983; HARTMAN et al, 1983; CLARK et al, 1984).

2.2 I.T. and Senior Executives

An important group within the web of interests must be Directors and senior executives. I.T. is publicised as a crucial matter for companies - so how involved were this group with the technology and its implementation? In each case senior executives were obviously focussed on key business matters, different for each, but generally in the areas of financial viability, product design, costs, market behaviour and people issues. None of these senior managers talked of an explicit strategy for I.T. - that is a laid down and understood plan for
introducing hardware and processes. There has of course been wide discussion in the literature about the degree and extent of strategy definition, and its several levels of creation and implementation (see for instance HOFFER and SCHENDEL's, 1978, suggested composite of strategies). And it must be said that for every senior executive interviewed (with the sole exception of the Chairman of 'Fashion') there were always super-ordinate executives beyond the scope of the research, who were influencing matters.

Nevertheless the overriding impression was that the interviewed senior personnel did not seem especially knowledgeable of, or interested in, the information technologies in improving organizational effectiveness. Nor, with some exceptions, were these executives giving strong leadership in the evolving I.T.-led changes associated with I.T. This is confirmation of a report by P.E. Consulting Services (1986) on attitudes and acceptance of I.T., and anticipated by DEARDEN (1983).

Throughout the upper ranks of all the companies there was seldom an enthusiasm for I.T. matching the supposed importance of the technologies registered in the media. Most of the senior executives had viewed I.T. as 'main-frame computing', with important but limited scope for reducing manpower and thus cost, in specific shop floor and clerical procedures. "Our first mistake was regarding the computer as a glorified accounting machine" (E-13) sums up this attitude.

In only one company ('Hardwear') was a Director responsible solely for Management-Information-Systems, and even there engineering applications were not within his province. Only in 'Components' did it appear that the whole gamut of I.T. was being driven from some long term and corporate plan, though this did not seem to include organizational design or management development in relation to I.T.

Senior managers were aware of the technologies - but often only in a general way. Certainly they rarely had detailed technical
knowledge. Managers at lower levels plainly regarded I.T. implementation as a matter of tactics. This was especially so at 'Fashion' and 'Integral' where absence of a plan was joked about. In all the companies senior executives were predominantly reacting to initiatives originating at middle-management levels, mainly from technological specialists. Confirmation of this comes from the BUTLER COX (1986) report which concludes that top management is too willing to regard an 'I.T. strategy' as a chore to be delegated to the systems department.

2.3 I.T. and Middle-Managers

The main dialectic to initiate decisions to instal I.T. systems was between M.I.S. (middle) managers, and their supporting enthusiasts amongst functional managers, and Directors. The discussions appear generally to be asymmetrical due to the extreme differences in knowledge of I.T., and its potential, between the 'designers' (M.I.S. for instance), and senior executives.

Accounting disciplines were widely quoted as acting against introduction of the technology. Proving, by cost-benefit-analysis, the advantage of a proposed application was commonly regarded as difficult. While the costs could be estimated easily, the benefits were problematic. Outcomes such as use of released floor space, better quality or reliability of the product or service, new learning by managers, are often impossible to bring into the equation. KAPLAN (1986 b) comes to similar conclusions regarding computer-integrated-manufacturing.

There is a certain inevitability of events as the costs of hardware (computer, automation, and telecommunication) continue to fall rapidly. Cost benefit analyses are thus seen to be moving unerringly in favour of technology-based processes. It is ironic that while cost-benefit analyses are often quoted as evidence for not introducing technology, post-event analyses are seldom made in any of the companies. Thus there is no accumulation of rigorous data either in favour, or against, I.T.
The web of organizational forces surrounding I.T. is convoluted. Certainly the tensions presented in the literature (FRIEDMAN et al, 1985, and MARKUS, 1983, for instance) between systems designers and systems users were found in all five companies. But the detail in each case revealed many cross-currents.

Both the 'designers' and the 'users' are not discrete entities: rather each group contains many interests and enthusiasms. On the designer side the various aspects, or component technologies of I.T., for instance office automation, plant engineering, telecommunications, software acquisition, are seldom co-ordinated. In no case was there an overall responsibility for these elements, and often communication between these several interests was poor. Examples of antagonism and competition between factions of the designers were quoted often.

Nevertheless, expertise of computing, and I.T.-based systems lay overwhelmingly with the designers, who were continually updating their knowledge through courses, and contacts with hardware and software suppliers. This was in contrast to the user-managers who were generally poorly informed on the technologies. But from the viewpoint of most managers there was another distinction. Designers, (both in M.I.S. and in plant automation functions) were seen as lacking in understanding of management and organizational processes, not least of the personnel dimension. This confirms findings in the literature, for instance, MUMFORD and HENSHALL (1978); MUMFORD (1981); COLLINS (1983 and 1984); WYNNE and OTWAY (1982); and NEWMAN and ROSENBERG (1985). All these point to designers relying on deterministic-rationalistic models of managerial behaviour, and lacking awareness of management practicalities. In both the BUTLER COX report 1986, and the EOSYS report (1986) executives express disappointment and frustration with M.I.S. departments, and the kinds of I.T. systems they are designing.

Another aspect considered important here, was the absence of liaison between system designers, and the Personnel function. Nor was there any indication anywhere that organization-design
was taking into account the possible, or even the desired, structural or process implications of I.T. For instance, specific training or preparation of managers for I.T. was rare.

Many operating managers spoke of the 'distance' between the proposers of change, often M.I.S., and themselves. They were virtually submerged in day-to-day detail management, and with little understanding of the technologies, were at considerable disadvantage in debates with the designers, and in I.T. implementation. With the exception of 'Components', there was a widespread conservatism amongst user-managers. Pressure to maintain the status quo was strong, and evidence of counter-implementation was often apparent. Managers maintained low personal visibility, or were reluctant to adopt new systems. Systems experts were cast as 'over-clever'; systems were characterised as confusing, or not useful. (In fact, a corroboration of the list of counterimplementation techniques given by KEEN, 1981). Indeed, the reluctance of U.K. managers to take on new responsibilities has been identified by SWORDS-Isherwood and SENKER (1978) as a major cause of Britain's poor performance in innovation.

The designers often used "counter-counter-implementation" approaches, such as seconding systems specialists to work alongside line managers, to assist introduction of new routines, or different technology, that is, becoming "insiders".

Overall, in spite of many problems, technology is spreading. Middle managers are gradually becoming more I.T.-knowledgeable, and their attitudes are slowly turning in favour of the technologies. What this research shows particularly is the web of interests associated with I.T. To say managers have choices in the use of I.T., as do some authors (see for instance Buchanan, 1982, and Hartman et al, 1983) is true. But the cases here reveal the many divergent interests, and levels of understanding of I.T. and its effects, amongst managers. The actual I.T. outcome in the short term is contingent upon several situational factors and not least upon the ongoing argument at
middle-management levels.

2.4 Imperatives in I.T. Implementation

The revealed pattern of implementation and usage was highly differentiated between companies, and between organizational functions. With little company-wide overview of I.T. at senior levels, the exact anatomy of I.T. applications resulted from particular enthusiasms and technical knowledge of managers, and their perceived potential for favourable outcomes. What often appeared to be lacking was the ability to synthesise I.T. expertise, and experience of the 'on-the-ground' management context.

I.T. enthusiasts were also faced with a massive momentum to maintain status quo (except at 'Components'), and extreme difficulties of bridging the gap in understanding of I.T. and its potential between themselves and user-managers. In fact abilities in creating and maintaining bridges appear to be crucial. Speed and effectiveness of I.T. diffusion was often dependent on key individuals (usually managers). (See for instance the roles of E-12 in Marketing, p. 100 and p. 103; the Sales Administration Manager H-2 in 'Hardwear', p. 135, and especially in 'Fashion' the wages clerk F-4, p. 165, and the production co-ordinator F-1, p. 171, who drove I.T. applications forward within a starkly unenthusiastic ambience). This confirms the oft-quoted observation that 'champions' are of critical importance in the introduction of new practices. (See BUCHANAN in WINCH, 1983).

However, each organizational function seems to have its own I.T. character. Computer-aided-design (except at 'Fashion') has been established for a decade, and basic financial systems for much longer. Personnel departments, on the other hand, in four companies were virtually untouched by I.T. And, again except at 'Components', manufacturing managers seem to have been the slowest to be convinced of the advantages of I.T.
In spite of the patchy, and often paradoxical patterns of I.T. use, it seems there is an underlying logic. Implementation is being driven by several separate but interlocking imperatives. These are sketched in Figure 5.1.

For clarity in the following analysis, the characterisation of I.T. usage introduced in Chapter Two, is repeated here:

a. the Management-Information-System (M.I.S.) part of the management data processes. This in turn can be divided into two forms:

i. transaction processing - the systematised electronic processing of standardized elements of data,

ii. decision support for control, co-ordination and planning at any organizational level and with any time horizon. Decision support may be a derivative of transaction processing - that is an automatic, planned outcome in terms of useful management indices; or it may be electronic processing of data relatively separate from the generality of operational transactions. In this latter case, functional managers commonly have autonomy of access to data, and the computer operations, (that is, independent of M.I.S.).

b. organizational communications - again in two forms:

i. as electronic mail, e-mail, which offers an alternative to face-to-face oral, telephone, and telex, arrangements, between people, within the organization, or between them and people in other organizations.

ii. as networks of terminals with rapid access to data banks. In this mode people are accessing stored information at various levels of derivation from the original data, and may be communication between people and the system, or between computers,
Figure 5.1 "Imperatives" in I.T. Implementation

Time 0

I Increasing distribution of access (with decreasing hardware costs) - functionally (horizontal) and hierarchial and thus increasing e-mail and networking.

II Paper-manual-mental systems

III Cost reduction focus

Added value focus

IV Transaction processing

Decision support

V Managerial Hierarchy

Junior
Shop floor operations tactical strategy
office floor control planning planning
transactions and control and control

Middle
Senior

VI Degree of Integration of Systems

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<th>Many</th>
<th>Few</th>
<th>Single</th>
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<tr>
<td>Entirely separate</td>
<td>Integrated sub-systems</td>
<td>integrated system</td>
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- 261 -
c. control engineering, that is those data processes associated with control of machine-accomplished physical activities, such as machining or assembly on the shop floor. These control processes may be integrated with other information systems in the organization. Control engineering is not included in this study.

This categorisation is regarded as important and in what follows will be referred to as:

a. Transaction processing
b. Decision support
c. e-mail
d. Networking, and
e. Control engineering and automation (on the shop-floor).

'Transaction processing', that is repetitive, usually low complexity, data procedures, have historically been carried out by large groups of clerical unskilled or semi-skilled staff. High volumes of transaction processing occur in certain functions such as accounting (payroll, billing, costing, ledgers), and in inventory control (purchasing, warehousing). But it also occurs (depending on the company) in other functions, such as production (production control, quality control, product specification, standards, and assembly routing).

Each function has therefore a specific amount, and degree of complexity, of transaction processing. Most of this has traditionally been handled by the 'serried' ranks of clerical workers at the lower-middle of the hypothetical organizational pyramid.

Computerisation is carried out most easily where there are high volumes of low-complexity transactions. And the incentive to management to reduce transaction cost through reduction in numbers of clerical workers (and this means increase in productivity) was especially visible in these tasks. Thus as
NOLAN has argued, the initial motivation for I.T. applications is cost reduction and takes place at these 'low' organizational levels. As computerisation moves sequentially (but in a largely unplanned manner) up the pyramid, volumes of transactions decrease, transaction complexity increases, and the potential for labour cost reduction is less.

Early computer-driven transaction processing was facilitated by hardware operation speed, by the relative ease of constructing software, and by inputting practices being straightforward. The greater difficulties of more complex transactions are increasingly offset by the continuing increase in hardware speed, by more effective later generation software and the improvement in telecommunications and display facilities.

The continuing and rapid reduction in cost per performance is driving the spread of terminals, personal computers, printers and shop floor automation. As hardware costs continue to fall the distribution of access of I.T.-driven systems is increasing in all the companies. The spectrum of I.T. usage, from 'Fashion', where there was only one personal computer in use, and few managers had terminals, to 'Components' at which micro-computers and terminals were commonplace, is wide indeed. But in both, the extension of I.T. use is continuing.

Transaction processing by main-frame computer produces management indices which are useful to operations planning and control - and have been so used in all the companies for years. 'Decision support' for managers, using independent personal computers and giving autonomy over data and computer packages has, since 1980, been spreading rapidly in all companies except 'Fashion'. By-and-large improved decision support is an 'added-value', rather than a 'cost reduction', imperative. However, these two imperatives in respect of decision support for managers are often inseparable. Better and faster decisions are an important constituent of manager productivity, and although giving added value, often have cost reduction consequences also. Combination of personal computers and their
access to main-frame networks, is allowing managers to 'download' data only available centrally, and then to have autonomy over data manipulation. This sophistication redresses the balance of data ownership in favour of user-managers.

Thus now in all the companies both cost-reduction, and added-value, imperatives are operating simultaneously. Further, reducing cost of hardware is driving spread of access. As repeatedly shown in this study several I.T. tendencies impinge on an organizational situation at the same time, making cost-benefits analyses extraordinarily difficult. In fact although the idea of such analyses were often introduced by interviewed managers, the practice of post event analysis was rare.

One other conclusion, considered significant here, is that as paper-manual-mental (P.M.M.) systems, or earlier I.T.-based systems, are replaced by later I.T. systems, there is usually a reduction in data redundancy, and a coalescence of sub-systems. The total number of sub-systems is thus reducing with time. The integration of data systems which this implies transcends organizational responsibility structures.

In summary, this research reveals the spread and use of I.T. to be weakly co-ordinated, with many groups of managers taking part in the unrolling debate, decisions and implementation. Certainly the twin NOLAN forces - for cost reduction, and for added value, - are prime, but the spread of access is itself a positive feedback in the acceleration of I.T. use. It would seem that the inherent characteristics of I.T. are driving organizations and their management inevitably toward higher levels of technology usage, productivity and systematisation. However, and importantly, it is inescapably seen that the nature of the developing new practices is strongly conditioned by the existing culture in each company.
3. IMPLICATIONS FOR MANAGERS

3.1 Preface

As the literature establishes, technology has always been a powerful agent for change, both in society generally, and in work. The definition of technology is not easy, and variations in definition undoubtedly give rise to problems in assessing conclusions of researchers. The commonplace view is that technology equates with artefacts, and more usually in today's world, with machines. The symbol $T^m$ will be used here for this interpretation. But as SCHUMPETER (1939) pointed out, technology may be regarded as including knowledge, concepts and practices as well as hardware. While this may be valid, and indeed may offer conceptual advantages, such a wide definition leads to extraordinary difficulties in identifying and separating technological effects. This wider definition will be given the symbol $T^+$ here.

Until recently, technology ($T^m$) has been primarily either within the product (for instance in cars, pumps, washing machines), or has been a substitution of 'machinery' for human effort and skills within the arena of physical processes. Its applications were thus mostly on the shop floor, and its effects mainly for labour processes. Historically, increasing technology in both products and in production, did have some concomitant implications for the work of managers, as is indicated in Chapter Two. However, the literature broadly implies that such technological applications were of no great consequence for management process.

Now the essential difference with Information Technology is that it is just that: technology applied to information processes. Although it has physical manifestations and consequences, it is within the arena of organizational 'intelligence' systems, discussed in Chapter Two, that I.T. is making its principal direct impact. I.T. is increasing the effectiveness of the total organization to process data. From this simple but
profound concept the whole range of implications of I.T. flows.

It is clear from the field work that this increased data processing effectiveness of I.T. can be conceptualised as resulting from three vectors:

the Technology Vector \((T_v)\)
the Systems Vector \((S_v)\)
the Productivity Vector \((P_v)\)

These vectors operate simultaneously, and in practice are highly interwoven. Nevertheless, this conceptual framework (see Figure 5.2) is useful in throwing light on the implications of I.T. on managers' work, and is discussed here briefly.

As BEER emphasises throughout his writings, an organization can always be considered as a system, and its various activities as linked sub-systems. But there is a range of 'hardness' of systems ranging from the hard control systems of a computer-managed machine, through less-hard accounting systems, to "soft" social systems. There is a parallel degree of deliberate intention in the design of such systems. In the harder cases of engineering and accounting, the systems are carefully designed, whereas social systems tend to evolve in a largely undesigned way. Of course certain organizational factors such as structure and training are important for the emergence of the social system specific to a particular company.

I.T., deriving from its generic characteristics discussed in Chapter Two, increases the extent of, and sophistication of, intended and designed, hard data systems. This is considered to be the Systems Vector \((S_v)\).

It is possible to imagine that without the \(T^m\) of I.T., that is using knowledge and concepts of data processing without the hardware, organizations might become increasingly systematized. But such non-technology (non-\(T^m\)) systems would suffer the inherent drawbacks of paper-manual-mental (P.M.M.) arrangements
## 5.2 Paradigm of I.T. Vectors and Managers' Work

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<tr>
<th>I.T. Vectors</th>
<th>Technology Vector (Tv)</th>
<th>Systems Vector (Sv)</th>
<th>Productivity Vector (Pv)</th>
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<td><strong>Managers' Work</strong></td>
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<td><strong>General Character</strong></td>
<td>Increases priority of data management</td>
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<td>Increases pace</td>
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<td>Reduces differences between managerial and non-managerial work</td>
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<td>Increases need for flexibility</td>
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<td>Increases need for technological and systems skills in managers</td>
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<td><strong>People Issues</strong></td>
<td>Reduces 'tiers'</td>
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<td>Reduces number of managers</td>
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<td>Changes labour skills</td>
<td>Increased team developments</td>
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<td>Increases subordinate 'professionalism'</td>
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<td><strong>'Interpersonal' Communication</strong></td>
<td>Electronic mail increases organizational transparency</td>
<td>Reduces number of people in the interpersonal network</td>
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<td>Reduces 'linking-pin' primacy of managers</td>
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<td><strong>Information Management</strong></td>
<td>Increased data access</td>
<td>Increases system centralization</td>
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<td>Increases organizational transparency</td>
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<td><strong>Decision making</strong></td>
<td>Increased decision support</td>
<td>Reduces detail personnel administration decisions</td>
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<td>Increased relevancy and priority problems</td>
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of which the greatest is probably slowness of operation. Pre-I.T. systems may operate at speeds slower than, and often much slower than, the 'actual' processes (of production, sales, decisions) they are associated with. I.T. offers specifically technological characteristics of speed, large, fast memories, interconnectability and access (and others discussed in Chapter Two) which, it is here suggested, can be seen as the Technological Vector ($T_v$). In other words, there are effects due to $T_v$ which would not arise from systematization ($S_v$) alone. Specifically I.T. systems operate at speeds as fast as, and often faster than, the 'actual' processes (of production, sales, decisions) they are associated with. This change from pre-I.T. systems is profound.

Taken together $S_v$ and $T_v$ increase the effectiveness of data processing throughout the organization and thus increases productivity both in offices and on the shop-floor. For a given output, numbers of people, both staff and management, fall, as will be discussed shortly. And from this Productivity Vector ($P_v$), derive many other consequences for managers.

Following the themes recurring in the literature the framework used in the field work and in the case presentations was:

The Character of Managers' Work
Managers and People
Managers and Communication
Managers and Decision Making

This format was found to represent well the actualities found in the companies and is used in this analysis.

3.2 The Character of Managers' Work

Overwhelmingly, the descriptions of managers' work and roles in the literature is evident throughout the company studies. Characterisations of that work as weakly defined, highly fragmented - with many brief episodes and much interruption and
attention switching - was shown to be the case in all the companies studied. Managers are usually involved in several tasks simultaneously, and constantly moving between them as they reassess priorities. Streams of oral, written and telecommunicated data impinge on managers from all sides, stimulating reactions of communication or action. The typical 'action-orientation' of managers described by researchers was commonly observed.

This basic nature of managers' work appears to be little changed by I.T. so far.

Another important conclusion is the variability of I.T. effects, for managers, and for the organization generally. Information technology has many forms and is interacting with complex, and different, practices in each case. Thus the exact implications for each manager are unique. While the tendencies discussed here appear to be pushing the organizations in 'inevitable' directions, in the short run the prevailing cultures are powerful in conditioning the I.T. effects.

Managers are acutely aware of the greater rate of change in recent years. Competitive pressures and the consequent implications for products, pricing, productivity, and organizational processes are much in their minds. But it is clear also that technology, and especially I.T., is seen as a major transforming force on their company and on management. While the popular press, and I.T. vendors, have grossly under-estimated the time scale of I.T. consequences in organizations, managers widely anticipate radical changes in the longer term. It is axiomatic that managers are crucially implicated in these changes. Though it is not a new phenomenon, the 'management of change' is a key component in virtually all the work of the managers studied.

I.T. is rarely perceived as a single technology by managers: rather, they spoke of those technologies, and those effects of them, that were impinging in their own spheres. Production
managers were concerned about automation, robotics and computer driven production control, and quality control, systems. Marketing managers were focussed on analytical 'packages', on customer enquiry response systems, and methods of updating sales people in the field using portable equipment and telephone coupling to office based computers. The point is that while I.T. has a common technological basis, its plurality is important.

This plurality means that I.T. expertise is usually, and naturally, divided between several functions. In no company was a single executive responsible for the total I.T. arena. Yet I.T. systems are succeeding traditional functional divisions: the organization is becoming a single integrated system. The transitions from the relatively 'separated' structural compartments toward this system entity provides difficulties for many managers with strongly functional perspectives.

Balance of attention

Earlier three vectors were suggested: the Technology Vector (T_v), the Systems Vector (S_v) and the Productivity Vector (P_v). The technology and systems vectors of I.T. are intimately bound together - but they are different. Technology, in the sense of artefacts or machinery (T^m) has historically been applied primarily at the shop floor. Thus managers in that arena have long been involved in technological matters. And in all five companies I.T. is facilitating increased technology at the shop floor. Inevitably the technological component of these managers' jobs is steadily becoming larger.

Technology, as machinery, has been encroaching office environments for many years (as telephones, telex, typewriters, copiers, etc.). But essentially, for decades office practices, and more importantly management practices, have been little changed by this technology (T^m). In its wider form T^+, to include concepts and techniques, technology has always been a part of management. I.T., neglecting for the moment its Systems
vector \((S_v)\), brings an increase in both machinery \((T^m)\), and in
concepts and techniques, to managers. The computer terminal and
personal computer are becoming a standard part of office and
management equipment, as the telephone became years previously.

But computer access is also bringing to managers techniques of
analysis and data reformatting unavailable previously - a
concept technology. This is interwoven with the systematisation
of data handling, discussed earlier.

Management has thus been forced by I.T. to become both more
 technological, and more systematised. Information management is
demanding a different and higher order of attention from
managers. Questions of systems design, modification and
operation, decision support, data value and priority, and the
associated choices of application of hardware and software, have
moved to centre stage for managers.

In the past 'management of people' had been the prime, if not
overwhelming, dimension of many managers' work. The relatively
low productivity regimes meant large numbers of people, and that
in turn produced an emphasis on personnel administration issues.
Managers became focussed upon, and at times submerged in,
matters of industrial relations, and social management.
Planning for, co-ordinating and controlling large numbers of
people consumed much management time and energy.

The productivity Vector \((P_v)\) of I.T. is arguably now beginning
to move these companies into a 'virtuous spiral' of faster
improvements in productivity, and especially information
management productivity, and so reducing numbers of staff. The
natural priority of 'social management' is therefore declining -
or to continue the thespian metaphor - it is moving off centre
stage.
The Adaptive Milieu

Not one of the companies studied could be called 'typical'. Yet, except for 'Components', their cultures, structures and processes can perhaps be characterised as 'traditional' in the British context. This implies: (the word 'relatively' is assumed in each case)

Well defined hierarchy
Many hierarchical tiers
High visibility of management authority and status
Well defined functions and departments
Boundaries difficult to cross
Low productivities in manufacturing processes
Low productivities in information handling (office work)
Large numbers of staff
Large amounts of attention on people issues and 'social management'

Except on shop floor, low 'technological' orientation of managers
Low attention by managers to information management
Low integration between sub-systems
Low organizational transparency
High specificity of data ownership
Low definition and 'ownership' of company goals and policy

It is argued here that I.T. is tending to reverse all these characteristics and transforming organizations from 'traditional' to a different state which will be termed the 'Adaptive Milieu'.

Within the Adaptive Milieu there is less weight given to 'designatory' structures, and more given to information management structures and processes. Because of the ubiquity of data access, stimulation to decision making and action is high. Thus managers are prompted to react quickly without time to consult upwards for guidance. Managers are therefore forced to decide autonomously which information to use, with whom to
communicate, and priorities of the moment. Previously designated rules, regulations and priorities based on the past become obsolete rapidly. As STAFFORD BEER (1975) points out "only variety can absorb variety" (ASHBY's law of Requisite Variety): "it is the rise in technology which allows the variety of individual behaviour". The individual middle manager is less guided by detailed rules, and needs knowledge of, and 'ownership' of, company goals and policy, so that he can react and proact in the most relevant way.

In a sense traditional organizations were based on strong designatory 'social' structures and processes, with weaker information structures and processes. The Adaptive Milieu reverses these, with the premium an adaptation. This is an extension from the 'organic' organization identified by BURNS and STALKER as preferred in situations of fast change. I.T. creates tendencies which force, and allow, a high degree of adaptation, and therefore call for qualities of creativity, initiative taking, flexibility and responsiveness of much higher order than hitherto. Within the Adaptive Milieu team building based on relevance of communication patterns, and relevance to task performance is prime and requires personnel management of a nature much different from that in traditional cultures. At 'Components' this is the general situation, but small, professional, colleague-like teams were also found in the other companies.

Naturally there are strains between the culture, structures and processes aligned with the designatory-hierarchical-traditional orientation and the Adaptive Milieu, which is emerging. There also exists tensions between those traditional patterns and the technological-systematic emphasis engendered and emphasised by I.T. Paradoxically, then, 'intelligence processes' are becoming more systematic, while interpersonal and social processes are becoming less so. As the spread and use of I.T. is proceeding in a largely patchy and somewhat unco-ordinated manner, the topography of these transitions, and tensions, is convoluted.
Management work character, and hierarchy

Patently the character of management work has always been a function of tier position in the hierarchy. Junior managers are concerned mostly with shorter time horizons and the immediate control of personnel and tasks. As the management hierarchy is ascended the focus moves increasingly to longer time scales and strategic planning and decisions. Undoubtedly this relationship of work and hierarchy continues.

Not surprisingly the implications of I.T. for managers are also hierarchy-related. It is at the middle and lower levels of the organization that the bulk transaction processes (of accounting, purchasing, inventory control) go on, and where the I.T. systematisation is most applied. It is the first and second line managers who are most aware of the labour reductions, labour skill changes, and the immediate sub-system effects, especially transparency and increased vulnerability.

It is at middle levels of the hierarchy that managers are most I.T.-involved. For there, computer-produced analyses are widely available; but also such managers are often using personal computers. User-designer debates on priorities and details of applications, and the transition issues from pre-I.T. systems are worked out at these levels also.

At the highest levels, executives have often received computer print-outs for some years, though such data is gradually becoming more sophisticated, timely and useful. Personal computers are rarely used by these senior managers, though. Indeed such managers are somewhat insulated from the direct effects of I.T., and this may partially account for their apparent lack of leadership in I.T. acquisition and development. The field work confirmed the oft-repeated findings that top managers are not well informed on, or especially enthusiastic for, the application of new technology.
The improvement in the effectiveness of information management creates the 'Productivity Vector' \((P_v)\) introduced earlier. I.T. is thus manifestly reducing labour content per output in all five companies. It has not been possible to evince clear correlations between I.T. application and numbers of people for several reasons. Firstly, this research is not a longitudinal study, and numbers of staff quoted by managers were impossible to validate, especially for past years. Also, in each company there were ongoing changes of staff in departments, and overall, related to various current issues. In addition, changes of structure and titles added further uncertainty. The reasons for lack of clarity were not always logistical: managers were evidently cautious in quoting specifics in the politically sensitive arena of reducing employment associated with new technologies.

Also, the impression was gained from managers, that notwithstanding some warmth towards I.T., they defended the need to hold their levels of labour. This is not surprising as managerial status is in some measure related to staff levels. The consequence is that there is probably a lag in labour reduction in relation to the take-up of I.T.

Nevertheless, in all five companies there was a general acceptance amongst managers that I.T. displaces staff. This productivity vector comprises several components:

- **a.** direct substitution of I.T.-driven processes and equipment, on the shop floor and in offices, for the effort and skills of people.
- **b.** reduction of data, and system, redundancy, which eliminates some tasks altogether.
- **c.** secondary reductions in tasks consequent upon reduction in numbers of personnel for instance in personnel departments, in cleaning and in refectories.
- **d.** reductions in 'tiers' in the hierarchy, partly related to
labour reduction, and partly to organizational transparency.

Examples of reductions are given in the case studies. (See Accounts Payable, 'Engineering', p. 99; Warehousing and Manufacturing, 'Hardwear', p. 138; the 'Westholt' warehouse at 'Fashion', p. 176; Manufacturing at 'Integral', p. 202, and at 'Components', the order-entry group, p. 232, and in Production, p. 233).

The reduced need for intermediate managers was often mentioned (see 'Engineering', p. 99) and confirms the findings of BARRAS and SWANN (1983) in the insurance industry. CHILD (1984), and ROTHWELL (1984) come to similar conclusions. This is in direct contrast with the pre-I.T. literature which even as late as 1977 (ARGYRIS) was lauding the importance of middle management in interpreting data for senior executives. In the research in this thesis the tendency toward flatter hierarchies was frequently mentioned though managers also said number of tiers were unchanged in recent years. This may again be a case of personnel and structural changes lagging behind events. There are echoes here of DAWSON and McLoughlin's (1984) study of computerisation of railway freight movements. They suggest that the new communication channels provided by the computer obviated the need for hierarchical reporting. One layer of management, in consequence, was expected to 'wither on the vine' as direct restructuring was frustrated by middle management.

There are also other non-direct effects of I.T. which tend in the direction of reducing staff. Patently, the size of electronic components, and thus of assemblies, is reducing. (See Chapter Two). Production managers frequently quoted equipment which a few years previously was the size of a filing cabinet and now was a single integrated circuit card. Thus the space needed in production facilities per throughput, is decreasing. This decreased volume per performance also was quoted in the applications of the equipment. It would seem therefore that the space required for a given turnover or output
A similar effect is created by reduction of system redundancy. Engineering design and manufacturing planning are now carried out centrally at all four engineering companies and transmitted electronically to relevant departments. Similarly, at 'Integral', fault diagnosis of customers' equipment is taking place electronically over telephone lines. These activities naturally have tended to reduce staff and space.

It seems inescapable that the 'traditional' low technology, low productivity organizations, which meant large numbers of people, and which itself created demands for more support and management roles, is now in reverse. I.T. in the companies studied is causing an upward spiral in productivity, a downward spiral in staff numbers.

The number of staff reporting to first line supervisors was only marginally down overall. However, generally, managers more involved with I.T. (the 'A' and 'B/C' groups) reported greater reductions of staff (see Appendix 2) responsible to their first line supervisors. Also there were several examples of small teams of professionals highly involved in I.T. systems.

The skills of workers were not studied but managers commonly introduced this topic. In their perceptions, as the lower complexity transactions were computerised, unskilled and semi-skilled jobs disappear - in offices, warehouses and on the shop floor. The work then associated with I.T. driven systems was usually seen as requiring 'higher' skills - especially calling for understanding the data system, initiative taking and independent thought.

Definition and classification of 'skills' is seldom easy, and this is especially so for mental and social skills. Paper transactions at lower levels of complexity are usually repetitive and require carrying out relatively explicit sequences of simple listing, matching, validating and filing.
activities. As these routines are absorbed into machine systems, the work that remains appears to be more 'management-like'. That is to say, the work is less definable and calls for workers to take initiatives.

A simple example of this is in word processing (widespread in all the companies), which reduces the need for perfect keyboarding (an 'old' skill of a routine type), and increases opportunities for creative layout (a new 'initiative' skill). Much of the early literature (BUCHANAN and BOODY, 1982; and CROMPTON and REID, 1983) finds that technology produces deskilling of clerical work. Managers in the research here often held the opposite opinion.

Managers also commonly believed that the access of their 'immediate' subordinates to information available to themselves is increasing. The increased access to the network, including electronic mail, has another important effect: it increases the expectation of rapid response. This in turn reduces the time available for upward consulting by staff, that is it increases autonomy at lower levels. When increased access is added to the perceived increase in autonomy and initiative taking of subordinates, the effect seems to be to reduce the differences between managerial and non-managerial work. (ROTHWELL, 1984, also noted this). A good example of this is the Distribution department at 'Hardwear' (p. 129) in which every staff member has a VDU and can call up a variety of data on product availability, product specifications, price and discounts. The telephone transactions with customers are carried out with rare references to the office manager (who in fact has no better information than his staff).

While there is wide variability in functions and departments, the persistent impression amongst managers is that the number of people for which they are responsible is decreasing, and the average skill and professional competence is increasing. Overall, reduced number of subordinates at any level must mean a reduction in 'personnel administration' in matters of
absenteeism, tardiness, health and safety, and records. The tendency upwards of increased access, autonomy and initiative taking, coupled with greater skills and qualifications is probably slowly changing the subordinate-superordinate relationships away from primary hierarchical, and towards a 'team', culture. This has already been discussed under 'General Character of Managers' Work. A summary of I.T. tendencies for 'people' issues is shown in Figure 5.3.

Figure 5.3 I.T. Tendencies for 'People' Issues

1. Reducing staffing due to direct I.T. applications.
2. Reducing staffing due to indirect effects (such as reducing system redundancy, and needed space).
3. Reducing number of tiers and intermediary managers.
4. Increasing skills and qualifications of staff.
5. Increasing data access at lower levels.
6. Increasing autonomy and initiative taking by staff.
7. Away from hierarchical and toward a 'team' culture.

3.4 Managers and Communication

As introduced in Chapter Two much that happens in organizations is concerned with communication, which is dealt with in this analysis under two headings. Firstly, information management, that is data capture, analysis, transmission (and other data mechanisms) of a 'designed' nature - for instance an accounting system. Secondly, interpersonal communication, which has a more informal, undesigned, 'social' nature.

Information Management

It is the increasing effectiveness in information management that I.T. confers, which creates the major consequences for
managers. The 'tendencies' produced by I.T. on this arena are summarised in Figure 5.4.

Figure 5.4 I.T. Tendencies for Communication

1. Information Management increasing in importance.
2. Reducing data redundancy.
3. Increasing integration of sub-systems.
4. Reducing redundancy of sub-systems.
5. Reducing number of sub-systems.
6. Increasing organizational transparency.
7. Reducing specificity of data ownership.
8. Increasing perception of data quantities.
10. Increased priority of data structures.
11. Decreased priority of 'designatory' structures.
12. Increased perception of pace.
13. Increased reactivity.
14. Increased problems of data relevance and priority.
15. Increased feelings of vulnerability.
16. Little electronic mail used (except at 'Components'), but increasing.
17. Where e-mail used extensively, initiative taking and boundary crossing increased.

Increasing importance of information management

Amongst the managers studied the time spent on systems design or modification, or directly using terminals ranged from 1 to 13.6 hours per week. Details are shown at Figure 5.5.
Figure 5.5  

Comparison of I.T. Involvement  

Per Manager

<table>
<thead>
<tr>
<th></th>
<th>Engineering</th>
<th>Hardware</th>
<th>Fashion</th>
<th>Integral</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B/C D B/C D</td>
<td>B/C D B/C D</td>
<td>B/C D B/C D</td>
<td>B/C D B/C D</td>
<td></td>
</tr>
<tr>
<td>a. Has VDU in own office</td>
<td>.1 0 .4 0 1.0 .2 .8 .5 .6 .3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Has PC in own office</td>
<td>.2 .1 .2 0 0 0 0 0 .4 .1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. No. of packages used</td>
<td>2.1 .4 1.8 .2 .6 .6 2.0 .2 1.9 .2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Hrs/week on systems design or modification</td>
<td>12.1 1.1 3.1 .8 2.3 .9 1.5 .9 1.6 .8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Hrs/week on terminals</td>
<td>1.5 0 4.9 .2 5.3 .5 8.3 .7 5 .3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. E-mail messages per day</td>
<td>.2 .1 .7 0 0 0 .4 .2 8.3 9.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This evidence is backed up by comments from most managers that computing and systems are a much greater component of their work than five years previously. Receiving computer print-outs is commonplace on all manner of subjects, inputting data directly onto terminals, or querying data bases via terminals, equally so. Personnel computers are spreading widely and in many instances used regularly in decision support.
It is an inescapable conclusion that these management activities were not taking place some years earlier - perhaps 5 to 20 years depending on the company. Such activities are replacing other work then carried out by managers. In the companies studied, early I.T. systems were an overlay of pre-existent P.M.M. processes, as suggested by HEDBERG (1980). As the experience of I.T. in the companies increased, there was an ever increasing conversion of P.M.M. transactions into I.T. driven processes. For instance, Figure 5.6 illustrates the accelerating expansion of I.T. at 'Engineering' (see p. 83 in Chapter Four).

Integration and Organizational Transparency

Prior to the spread of computerisation, organizational functions and departments had their own P.M.M. systems, often designed without strong overall company co-ordination. Each of these essentially separate sub-systems, limited in extent by 'designatory' structures, for instance department boundaries, and by lack of technical facilities, had their own data files. Thus there is in such cases a high degree of separation of sub-systems and files, and a low level of co-ordination of data and systems. As P.M.M. routines are increasingly converted to I.T.-driven systems there is generally a reduction in data redundancy, a reduction in sub-system redundancy, and an increase in 'tightness' of systems in terms of timing, format, routing, access and synchronisation. Sub-systems are absorbed into more wide-ranging systems: the number of discrete sub-systems reduces. This integration effect of I.T. has been noted by NOLAN (1979), BARRAS and SWANN (1983), WINCH (1983), BESSANT (1983) and RAJAN AMIN (1985).

Integration appears to develop as follows:

Stage 1   Extant sub-systems (say) A, B and C (which may be paper-manual-mental, or earlier form of computer system).

Stage 2   System analysis and design consultations and planning, while A, B and C continue.
Stage 3 New system D installed incorporating A, B and C, resulting in:

a. strong designed-in coherence of A, B and C.
b. reduction in staff.
c. less direct co-ordination between A, B and C by managers.
d. less direct personnel administration (due to less staff) by managers.
e. reduction of data redundancy within A, B and C.

Stage 4 A, B and C sub-systems vanish. D seen as single sub-system being considered for integration with similar sub-systems, E and F.

As sub-systems A, B and C transform to D, the system effects may be rapid: the new system comes on-stream immediately. Characteristically, de-bugging of the new system can take weeks, and even months in difficult cases. However, some effects are sudden: several examples were found of immediate reductions in personnel and changes in working procedures. (See 'Engineering', APT, BIGL, and UNIPAY-UNIPERS-UNIPENS, pp. 85 and 86; 'Hardwear', despatch control, p. 129; 'Fashion', warehouse, p. 166).

Whereas managers had often had some control over the design and operation of P.M.M. sub-systems, and over relevant data files, the design and control of the more sophisticated I.T.-driven systems are moving away from them. Design responsibility, even when there is consultation with operating managers, is with a central 'Management-Information-Systems' staff. Much of the original system management (of A, B and C) is built into the system (D) itself. There is then a decreasing net amount of management (by people) as integration proceeds.

The reduction of sub-systems, and integration between them, was widely seen as reducing the 'fuzziness' of the organization, especially across department or functional boundaries (see 'Engineering', E-18, p. 108, and E-10, p. 109).
<table>
<thead>
<tr>
<th>Date</th>
<th>Computerised Transactions</th>
<th>Millions of instructions per second (MIPS)</th>
<th>On-line Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960-67</td>
<td>Payroll, General Ledger</td>
<td></td>
<td>(batch entry)</td>
</tr>
<tr>
<td>1968-73</td>
<td>Above plus Material and Production Control; Engineering and Personnel Records</td>
<td></td>
<td>(batch entry)</td>
</tr>
<tr>
<td>1974-78</td>
<td>1.5</td>
<td></td>
<td>(batch entry)</td>
</tr>
<tr>
<td>1979-80</td>
<td>2</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>Above plus Engineering design; Manufacturing assembly; Accounting/ Costing; Dealer voice response; order data; purchasing</td>
<td>40</td>
<td>600</td>
</tr>
</tbody>
</table>

Clearly the extent and importance of information management is increasing, and especially so since 1981.
Traditionally, organizational structures (designatory structures) have been based on relatively autonomous functions, (such as Marketing). Happenings within these units were largely contained within their own cultures and systems, and 'intelligence' about them was transmitted by unit managers after suitable filtering. In this transmission of information managers acted (and still act) as a 'linking-pin' (LIKERT, 1961).

As systems become integrated, indices useful in work monitoring, or for decision making, are automatically produced, and transmitted across boundaries. Not only is such information moving across functional boundaries - it is accessible (to anyone with authority to access it) up the hierarchy. At 'Fashion', for instance (p. 170), a Director with a terminal in his office, monitors operator efficiency - information automatically derived from production control systems. (See also 'Engineering', E-28, p. 95; 'Hardwear', H-2 and H-3, p. 144). It is thus more difficult for managers to conceal the immediate reality from their super-ordinates. As BURNS, NEWBY and WINTERTON found in coal mining, this process increases supervision and control by senior managers as they gain information instantaneously with the local managers. The elimination of, or at least reduction in, intermediate 'linking-pins' in information transactions is reducing delays between actions, and knowledge of those actions being widely available. Also, as many managers said, the actualities are concealed with difficulty. (See 'Engineering', E-7, p. 108, and E-10, p. 109; and 'Hardwear', H-3, p. 144).

This loss of 'ownership' and control of data, coupled with increased organizational transparency, is frequently perceived by managers as increasing their vulnerability. Another associated feature comes from the the opposite direction: their subordinates are now often able to access data as easily and quickly as the managers. In fact in some circumstances, especially where managers are not terminal-skilled, subordinates have better access than their managers. I.T. systems thus increase the 'sphere of visibility' of users, both managers and
non-managers.

The increase in spheres of visibility, the reduction of the primacy of functional boundaries, and the movement toward 'real time', are all factors improving the understanding of middle and senior managers of activities in the 'lower' reaches of the organization. This then is changing the balance of power - away from supervisors and junior managers.

It has to be emphasised that the degree of corporate level planning of computer based systems was found to vary greatly. Thus the advantages of reducing data redundancy, and of integrating sub-systems were, as yet, being achieved only in the more experienced and sophisticated situations. At 'Fashion' there was no co-ordination of hardware, software, or data systems between the two computer centres, and thus no integration. On the other hand at 'Engineering', an overview computerisation committee had been in existence for years, and undoubtedly integration and coalescence of sub-systems were occurring. Though even there, complaints of 'lack of co-ordination' were frequent from managers.

However, in each company, there was a definite trend towards greater corporate overview of systematization, with an anticipation amongst managers that numbers of systems will diminish, as will data and system redundancy. (See for example, the integrated manufacturing system expected at 'Hardwear', which will integrate production scheduling, inventory control, purchasing, engineering specification, and control of production equipment, p. 127).

This indicates an increased centralisation of design and operation of systems. Indeed, whereas previously P.M.M. arrangements were to an extent limited by responsibility boundaries, and thus under some control of local managers, computer systems are not. Because of the current sophistication of software, the available size of data bases and the widespread access to terminals in the more advanced companies, I.T. systems transcend
responsibility or functional boundaries.

This increasing overview of computerisation applies especially to transaction processing, which is characterised by repetitive data processes amenable to definition in terms of format, timing and routing - for instance accounting.

Data quantity and relevance

Although electronic transactions are increasing in volume in all five companies, and although such transactions are patently absorbing paper systems, managers commonly complained that the amount of paper is increasing. It seems that as more printers, and copiers, and faster printers, become widely available paper output increases. M.I.S. specialists thought this would be an intermediate phase, and that paper would eventually decrease, as V.D.U.s increased in distribution. However, managers are as yet not sufficiently experienced in terminal use to do without the convenience, and security to themselves, of having paper records at hand. (See 'Integral', I-5, p. 208).

Managers usually perceived the quantity of data available to be increasing - which is probably related to several factors. Firstly, there is the increase in amounts of paper mentioned above. But in addition there is the increased distribution of data, because of the increased terminal access, and increased organizational transparency. A consequence of this data overload are problems of priority and data relevancy which many managers felt and which were undoubtedly acute in 'Components', the most advanced I.T. user. These issues are treated under Decision Making, to follow.

Interpersonal Communication

Interpersonal communication, in all five companies, remains at the heart of management processes. Talking with subordinates was everywhere regarded as of high importance by the surveyed managers. Similarly the whole panoply of consultation amongst
managers continues. The only direct application of I.T. in this arena is in electronic messaging (e-mail).

All the evidence suggests that in each company the patterns of interpersonal communication are deeply embedded within the culture, and as yet, are little changed by e-mail.

E-mail is used at 'Components' about 100 times as much per manager as in the other companies, though of course this is partly because of the higher availability of terminals. But at 'Components' the culture is highly favourable towards initiative taking, and flexible and experimental approaches by its staff who are therefore less constrained by 'designatory' structures than their equivalents in the other companies. The extensive e-mail usage therefore grows out of that culture, and is continually reinforced by it. In the other companies the cultures, though all different, tend to be less positive toward initiative taking, and especially toward boundary crossing and experimentalism, and in each e-mail is little utilised. This even applies at 'Integral' where the technology is well understood and terminals widely available.

The sources of change in interpersonal communication relating to I.T. derive from its effects on information management and on decision making (the Systems and Technology Vectors), and in reducing and upskilling staff (the Productivity Vector).

Oral communication appears still to be a dominant management behaviour. Managers claimed their (mostly oral) consultations with subordinates, peers and superordinates had increased in recent years. There was no change in numbers of 'meetings'. Even allowing for wishful thinking, all the survey and interview material tends to show an increased importance given to interpersonal relationships generally.
Managers generally found this area the most difficult to recall and to disaggregate. Patently, decision making, as many researchers have found, is an amalgam of "negotiations, habit, rule of thumb and muddling through" (KEEN, 1980); quantified analysis of data is a minor contributor. However, the prevalent opinion in this research was that decisions are becoming more difficult, and more complex. The current market climate was undoubtedly seen as the principal reason for these difficulties. Certain characteristics of increasing I.T. also appear to increase managers' perceptions of complexity. (See Figure 5.7).

Figure 5.7 I.T. Tendencies for Decision Making

1. Increasing transaction processing (i.e. systematic communication) incorporates some decisions in programs, i.e. 'minor' decisions automated.
2. Integration of sub-systems allows automatic verification of some decision data.
3. Increased computer support in decision making.
4. Reduced data redundancy and 'clearer' data.
5. Increasing organization transparency leading to increased manager vulnerability.
6. Increasing perceptions of decision complexity.
7. Increasing decision prompting and manager reactivity.
8. Movement toward 'real' time.
9. Manager perceptions of greater data quantity: problems of priority and relevance.
10. Increasing data structure priority.
11. Decreasing organization structure primacy.
12. Increased 'pace'.
13. Increased need for goal/objectives structures.

In approaching decisions, increased organizational transparency
allows managers to draw relevant data from many sources, including from across functional boundaries. Similarly, post-decision consequences emerge rapidly from those sources, often automatically. Computer derived management indices starkly point out results to an extensive audience. And, as previous sections have shown, with time, a greater proportion of the company's operations are falling into the systems net.

Computer aids to decision making are increasing in all companies. Computer print-outs giving comparisons of results over time, or against objectives, are ubiquitous. Managers in many functions quoted their use of such data - in production, quality control, marketing, warehousing, distribution, personnel and others. In its most advanced form, in 'Components', such information is used in virtually every decision and every discussion. Specific 'decision support' by computer 'packages', for instance in decision 'modelling', is also spreading, though is still a minor contribution to decisions. However, in 'Components' such support is commonly available to managers. Aids like this are usually welcomed by managers, who claim they reduce delays in decision making, and improve decision quality.

As has been often mentioned here, managers commonly associate I.T. with increase in 'pace' of their work. This seems partly a communication factor, that is data is available faster; and partly a decision-prompting phenomenon. As 'Components' is by far the most sophisticated I.T. regime, it may indicate the kinds of future likely to develop in other companies. A rich network of terminals exists for most managers, and many non-managers, - indeed an office without a terminal is unusual. Accessing the network for data, and for derived indices, is used continuously by most staff and managers. In addition, electronic mail is used about 100 times more often than in the other four companies. Managers are thus being prompted by this network for decisions, or for action, at a very high frequency. This accords well with a culture which acclaims fast response, and is accepted as 'normal' or even 'favourable'.
In contrast, at 'Integral' in spite of also being an advanced technology company, the I.T. network was very much less used in management decision support. Also, although there were problems of 'isolation' between sites, electronic mail was hardly used at all. Evidence, it is suggested, of the critical role of the prevailing culture in influencing I.T. use.

Managers generally saw I.T. as improving their decisions - even in less sophisticated environments, such as at 'Fashion'. Usually that perceived improvement is associated with speed of data being available. It is postulated that several processes are again implicated. Time delays between an event in any function, and data on that event being available are being shortened substantially by I.T. In some circumstances (see for instance quality control at 'Hardwear', p. 150) instantaneous data is available. Also time delays between decisions, and their being received at the operational point are also diminishing. Further, the traditional 'linking-pin' managerial mode in which information was passed up and down the hierarchy, and modified in the passing, is being replaced by more direct systems. It is suggested that all this gives managers a more immediate, and probably, a more real view of events. Hence, the perceptions of I.T. improving decisions amongst managers.

As discussed earlier, I.T. is also tending to reduce definition of roles, both managerial, and non-managerial. The primacy of 'designatory' structures, and conformity to 'traditional' communication patterns, is decreasing. In this regard, managers often expressed feelings of uncertainty. Again, this is to be expected. In companies of a 'traditional' type, such as 'Engineering' and 'Hardwear', organizational structures - boundaries and hierarchy - were well defined, and slow in changing. While this may have created some disadvantages for the company in terms of reduced initiative taking, it did confer the advantage of giving security and confidence to managerial staff.

In 'Components', in every way different from the other four
companies, there seems never to have been a solid structure. Rather that company has always been a dynamic, flexible and responsive organization. The effects of I.T. thus are resonant with the inherent culture, and reinforce it. 'Components' also has two important mechanisms not apparent in the other companies. Firstly, there is a strong regime of forward planning, monitored and guided by computer. This forces managers to create plans and budgets for a long time scale ahead, and to update these annually by prescribed dates. Secondly, consensus on future company directions and policies is sound: managers have a high confidence in the framework against which they take decisions. Both these mechanisms appear to provide managers with a stout knowledge base, and to imbue the whole managerial corpus with resilience and positivity. Naturally these qualities derive from the whole culture and not only from the two mechanisms mentioned. In any event, the longstanding conventional structures in the 'traditional' organizations are being weakened, and as yet are not being replaced by the 'Components' type mechanisms. The consequence is increased uncertainty for managers in these situations.

As has been noted, I.T. is reducing numbers of staff, and probably increasing staff autonomy. It is therefore postulated here that managers are less called upon to take many minor decisions on personnel administration matters. The decision 'clutter' of these subjects is decreasing, and managers are released, to an extent, to focus on matters of longer time scale and of greater weight. In fact, surveyed managers commonly reported that strategic and planning elements in their jobs were increasing, as was the time horizon ahead on which they were focussing.

In all five companies then, I.T. is gradually extending its influence, and creating many implications for the work and roles of managers. Chapter Six sets out the conclusions from the research, and reflections on their relevance to management and management development.
"I have an increased horizon with regard to information - rapid data movement is paramount; my job is more and more about managing data and decisions. I ask myself with less people - what is a manager?" Manufacturing Manager - Hardwear
INTRODUCTION

At the commencement of this research the main questions seemed to be:

(from Chapter Two)

A. What is the character of I.T. diffusion and implementation in the companies?

B. How is I.T. changing the general nature of managerial work?

C. How are specific components of manager's work, namely communication, decision making and interpersonal matters being affected?

D. To what extent are the implications of I.T. on managers dependent on existing management practices and cultures?

From these, and drawing on the literature, and on personal experience, the set of hypotheses in Chapter Three were formulated.

This initial framework informed the fieldwork which eventually ran to 49 visits to the five companies, and 101 interviews with managers. With the additional tool of the questionnaire survey, and taking into account the observation facilitated by such an extensive exposure to company environments, the revealed data are rich in detail. As the five companies were so different, not only in their organizational culture, structure and processes, but also in the extent, sophistication and pattern of I.T., a very broad picture was obtained.

Using the systematic accumulation of managers' comments within the 37-element data base (described in Chapter Three) and with
due regard to organizational function and hierarchical level of managers, the story for each company emerged. Integration of these stories into a coherent, though multi-faceted characterisation, was presented in Chapter Five.

It remains for conclusions to be drawn and meanings to be wrought in this last chapter.

RESULTS AND THE HYPOTHESES

The hypotheses were a useful starting point. But as the field work proceeded, it became clear, even with a long personal experience of management in general, and the management of these companies in particular, that the nature of managerial work and its interaction with I.T. was much more interwoven than had been appreciated at the outset. The conclusions go significantly beyond the simple framework suggested by the hypotheses. Nevertheless, for completeness these hypotheses with brief comments derived from analysis of the data, are set down here; a first approximation, as it were.

H-1 that the number of people reporting to any manager is decreasing.
Comment
The evidence is not unequivocal on this point. Certainly, the total number of staff in each company is reducing but so is the number of managers. Where I.T. is used extensively managers have smaller staff complements than hitherto.

H-2 that the proportion of professionals and skilled people in the subordinate group is increasing.
Comment
This was found in all companies.

H-3 that the responsibility of any manager for data and for artefacts is increasing.
Comment
The information management component of managers' work was everywhere gaining in importance. Also, managers are generally responsible for more technological hardware.

H-4 that the technical, (i.e. related to machines, data and systems) components of any manager's role is increasing.

Comment
It is an important conclusion of this work that I.T. is increasing the 'technical' aspects of managers' roles, viz-a-viz 'social' components.

H-5 that managers are increasingly using electronic data and message handling.

Comment
In 'Components' e-mail is used substantially; in the other four companies it is used hardly at all, though its use is growing slowly.

H-6 that managerial activities concerned with integration and function boundary crossing are increasing.

Comment
This was found in all companies.

H-7 that there is a diminution in the managers' greater access to data relative to permitted access of other role holders.

Comment
This was confirmed in general.

H-8 that the data progress chasing activities of managers are decreasing.
Comment
Progress chasing seems so far not to be affected by I.T.

H-9 that planning is increasing and controlling is decreasing in the roles of managers.

Comment
Managers believed their time horizons were extended by I.T. and that they are giving more attention to 'formal' planning. On the other hand I.T. tends to weaken informal, personal planning due to its 'prompting' nature. The detailed 'monitoring of staff' component of managers' work seems to be decreasing.

H-10 that I.T. is producing local effects and concomitant effects distant from points of application.

Comment
This is a widespread feature and is called the 'field effect' of I.T. in this thesis.

H-11 that the I.T. system is carrying out increasingly higher "intelligence" organizational processes previously carried out by people.

Comment
This was found in all companies.

H-12 that organizational specificity in terms of data, timing and systems is increasing.

Comment
This was found in all the cases.

H-13 that the difference between management and non-management roles in terms of access is decreasing.
Comment
This was shown to be taking place widely.

H-14 that management roles are becoming more team-like and less hierarchical.

Comment
This is taking place in all the companies in a general way but is most prominent where I.T. use is intensive.

H-15 that organizational roles in general are becoming less routinised and call for more initiative taking, and that management roles are becoming less definable in terms of routine.

Comment
This was commonly found to be happening.

H-16 that managers' apparent activity rate is decreasing and reflective activities are increasing.

Comment
The very opposite of this was found everywhere. I.T. increases the pressure on managers to respond quickly; thus their 'pace' of work is increased and they have less time for reflection.

H-17 that as I.T. permeates an organization all roles gain more managerial activities, and the distinction between management and non-management roles decreases.

Comment
Intensive use of I.T. seems to blur distinctions between management and non-management roles, and to increase management-type behaviours such as initiative taking, flexibility and professionalism.

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Overall Conclusions

The overall conclusions naturally go beyond the brief comments on the hypotheses set out above. Those conclusions, following the order throughout this thesis, are clustered into five groups, namely:

A. Implementation

B. The General Character of Managers' Work

C. People Issues

D. Communication

E. Decision Making

A. Implementation

1. Information technology consists of several interwoven technologies and processes entering organizations in:

a. transaction processing - the systematised electronic processing of standardized elements of data handling;

b. decision support for control, co-ordination and planning, at any organizational level, in any function, and with any time horizon;

c. electronic mail - messaging between people within the organization, or between them and people in other organizations;

d. networking - the provision of distributed terminals allowing rapid access to data banks and to computer analysis and synthesis. This may be communication between people and computers or between computers;

and
e. control engineering associated with machine-accomplished physical processes.
2. I.T. developments are growing from precursors - telephones, telex, punched card machines and previous computers. There are no discontinuities, and in the short run, no revolution. However, the electronic technologies and their applications do possess distinct characteristics which are changing organizations and their management in radical directions in the longer run.

3. The unique culture of each organization is powerful in conditioning the exact I.T. diffusion, usage and implications. In all situations, there is some degree of contention between change-dominant techno-economic forces and change-resistant cultures, structures and practices. But this contention is neither simple, nor linear. Rather there is a multi-directional web of interests which is itself changing.

4. There has been an acceleration in recent years in managerial realisation of the potential of I.T., and in the spread and use of the technology. The reducing cost of hardware, especially of personal computers, is a strong influence in this.

5. With some exceptions the most senior managers did not appear to be knowledgeable of, or especially interested in the information technologies, and were not leading the evolution of I.T.-based changes. Nor in any company was there an explicit strategy for I.T. in the sense of a laid down and understood plan for introducing and using I.T., and for preparing people for new I.T. based practices. Most managers believed I.T. diffusion and usage were matters of tactics.

6. The main dialectic to initiate decisions to install I.T. systems is between managers in the 'Management-Information-Systems' (M.I.S.) function and Directors. Accounting practice of cost/benefit analysis is widely regarded as acting against I.T. introduction due to the difficult-
ies of quantifying benefits.

7. Practicabilities of implementation, usage and implications are worked out almost entirely at middle and junior management ranks. Most application initiatives come from M.I.S., though successful implementation depends greatly on key individuals - 'champions'.

8. M.I.S. staff had the overwhelming advantage of expert I.T. knowledge in discussions of applications with operating managers. However, user-managers generally regarded M.I.S. staff as having inadequate understanding of management and organizational process, not least in the personnel dimension. Not surprisingly there was tension between system designers and users though this was not linear. Rather it was convoluted by various levels of knowledge and enthusiasms amongst managers.

9. In no company was there close liaison between M.I.S. and the Personnel function, nor was I.T. and its implications given great consideration in organizational design.

10. In its earliest stages I.T. is applied at operational levels in the company. It then proceeds up the hierarchy converting increasingly complex and low volume activities to computer-assisted operation. Early I.T. diffusion tends to follow a 'cost-reduction' imperative, but 'added value' later becomes important, though both these motivations operate together.

11. In no case was there a single responsibility for I.T. implementation. Rather, because I.T. applications involve several technologies (plant automation, office automation, telecommunications, software and so on), responsibilities are divided and often there was only weak co-ordination between the various applications of these technologies.
B. The General Character of Managers' Work

1. The basic nature of managers' work is little changed by I.T. It remains highly fragmented, weakly defined, action orientated, with much attention-switching as managers continually re-assess their priorities. Oral communication continues to be a prominent feature.

2. Effects of I.T. on managers are various, depending specifically on the form and extent of the technology, and the nature of each manager's practices and environment. In the short run the prevailing cultures strongly condition I.T. effects.

3. Although management has always been concerned with change, the current transitions being induced by I.T. are major and rapid. 'Management of change' will be a central focus for managers for the foreseeable future.

4. The balance of attention is changing for managers. I.T. is forcing a more technological orientation, and causing managers to give more time and priority to information management.

5. As I.T. increases productivity and reduces numbers of people in organizations, the historical 'natural priority' of 'social management' is being eroded. The amount of detailed personnel administration is reducing.

6. Because of the reduction in numbers of people, and the increase in professional skills of subordinates, the changing nature of information management, and the weakening of 'designatory' structures, there is a greater tendency toward adaptive behaviours: termed 'the Adaptive Milieu' in this thesis. Smaller teams of staff with colleague-like relationships are beginning to replace the larger, more hierarchical functional groupings.
7. The classic tension between centralisation and decentralisation continues and is unresolved by I.T. Some effects of I.T., for instance increased organizational transparency, act toward centralisation, while others like the increased pressure for subordinates to react quickly, forces delegation, that is, decentralisation.

8. I.T. effects have so far mainly been on middle and junior managers: they are directly impacted by the issues of reducing staff, weakening of boundaries, more availability of data access and so on. However, senior managers are beginning to be affected by the encroachment of I.T.-driven decision support, and the increasing awareness of the strategic influences of I.T.

9. The greater organizational transparency, the rate of change and the new emphases on technical and systems matters, are together increasing perceptions of vulnerability in managers.

C. Managers and People

1. I.T. is increasing productivity, and thus, for a given output, is reducing numbers of people. This 'higher productivity, smaller work force' tendency has a multitude of consequences for management.

2. Traditional, practical skills are disappearing; new conceptual skills related to information management, and to operating in more creative, flexible, less routinised ways are developing. As these skills are required by both non-management staff (information workers) and managers (knowledge workers), to an extent, differences between these roles are diminishing.

3. The priority of 'designatory' organizational structures is reducing: functions are more integrated, boundaries and tiers, less defined. The previous rather 'skeleton-
ised' and static nature of organizational structures is becoming more amorphous and dynamic. Patterns of interpersonal relationship and communication are thus less constrained. There is therefore a trend towards 'node-to-relevant-node' communication, which may bypass some managers at times, and increase uncertainty.

4. Management of people is becoming less dependent on hierarchical authority, and more on leadership related to professional respect in a 'team culture'. This is due to a combination of reducing workforce, more conceptual skills, and increasing subordinate autonomy. This emerging 'adaptive ambience' places more focus on appropriateness to the task at hand, and on development of responsiveness of individuals, practices and structures.

D. Managers and Communication

1. Communication has always been for managers a composite of 'information management', and 'interpersonal communication', the latter being predominantly oral. It is the increasing effectiveness in information management which I.T. confers which creates the major consequences for managers.

2. Information management is becoming a more central component of managers' work. Use of terminals, and involvement in design, implementation and management of systems is expanding.

3. As the use of I.T. increases, data and systems redundancy reduces, as does the number of sub-systems. System tightness in terms of timing, format, and synchronisation between functionally based data procedures is increasing. Thus integration of activities is improving.

4. The reduction of specific data-ownership, the increased
organizational transparency, and the tendency toward 'node-to-relevant-node' communication, increase uncertainty for managers.

5. Managers perceive an increase in paperwork with increasing I.T. and also increases in the amounts of data available. This creates problems of data relevancy and priority for managers.

6. Interpersonal communication, and that is mostly oral, remains at the heart of the management processes, and is, as yet, little changed by I.T.

E. Managers and Decision Making

1. At transactional processing levels, decisions are increasingly being absorbed into the computer system.

2. Because of reductions in numbers of staff, detailed personnel administration and associated decisions are reducing.

3. Computer decision-support is increasing though is mostly at operational and tactical levels.

4. Computer produced analyses and print-outs are widely used at all levels of management where I.T. is at a sophisticated stage of application.

5. Several effects of I.T. combine to produce greater uncertainty amongst managers, which offsets the gains in information clarity, availability and speed of access conferred by I.T.

6. Because I.T. tends to weaken certain aspects of conventional structures it appears to be important for managers to have a strong consensus about company policy and strategy against which to take decisions.
REFLECTIONS

Although there has always been management, be it of religious orders, or sailing ships, or armies, it is only in the last hundred years that it has become so thought about, written about, and latterly, researched. A paradox runs through this century of examination: management is changing yet management is staying the same. Managing the sweatshops and quill-pen offices of the nineteenth century must have been a world apart from the management of today's technologically-based factories. And yet the essentially fragmentary, low structured, action-orientation, oral nature of the manager's job remains. The application of I.T. in and around the work of managers in recent years does not seem to have changed this basic nature.

It would be tempting to conclude that the changes of history - from Satanic mill to electronic office - are then principally metamorphoses of context, leaving largely untouched the art and skills and practices of leadership and governance that management is. But this is not so. The historical unfolding of social, political, psychological, economic and technological factors, we may conclude, have always been conditioning management. Information Technology is only one of current conditioning factors, and yet for the reasons set out in this thesis, it has the potential for bringing large and radical change to management roles. For I.T. is transforming not only the organizational context, but also the balance, emphasis and practices of management work itself.

Although 'small is beautiful' has been with us since 1974, it is only since perhaps 1980 that the application of the electronic technologies, coupled with the current political and economic stringencies, has facilitated a sea-change in the personnel dimension. Organizations are now on a downward spiral in terms of size of labour force, a trend which I believe will continue.

All five companies in this study have had a history of growing number of personnel until this decade. The two mechanical
engineering companies, in particular, had organizational cultures, structures, practices - and problems - which resulted from a large and relatively unskilled population of workers. A complicated panoply of personnel and industrial relations activities evolved. Strongly demarcated departments and hierarchy guided and inhibited managers. The continual pressure of social management overwhelmed managers. While this scenario was not universal in Britain, it is not untypical. Not surprisingly, the emphasis in management education and in manager development has been on social management. Theories of the social psychology of management have been prolific, if not universally enlightening.

Now the numbers are declining, demarcations, and dependence on hierarchical authority, is dissolving. The focus of managers is turning from the many to the few. The social-dynamics of this few, the team, will be crucial, but it will be a different kind of management. Creativity, initiative-taking, non-routine, fluid communications, and attention to the relevant and to the individual will be prime. And all this is already seen at 'Components', and in isolated cells elsewhere. In their important work on innovation BURNS and STALKER (1966) describe the 'organic' organization as being best suited to unstable conditions. I have built on this idea in two ways. Firstly, I.T. appears to be a destabilizing force pushing organizations toward the more fluid, responsive culture, which is termed here, 'The Adaptive Milieu'. Secondly, the effects of I.T. as have been set out in this thesis go far beyond the mostly structural issues considered by BURNS and STALKER, and include cultural and process adaptation. There are echoes here also of the 'flexible specialization' discussed by PIORE and SABEL (1984).

This research shows also that the centre stage is being taken by information management. Of course, taking sound decisions has always been at the heart of effective management. And creating effective information assembly, analysis and dissemination has always been necessary for those sound decisions. Once again, "plus ça change ..."). The difference is technology. Now, and
in the future, managers have available a systems technology of prodigious, and possibly unimaginable, power and speed. And from a management education and development view-point this is new. For although systems theory and practice has been taught to computer specialists for decades, managers are relatively naive in this field. Not only that, but their natural propensity is towards action, discussion, fragmented and reactive behaviours - not towards reflective analysis and technological orientation.

Dynamic computer models of sections of the business, and eventually the total business, updated in near-real time, with various formats and elements instantly re-analysable are a long way off still. But it is in that direction that management is moving. Much of the current tension and confusion amongst managers is due to transition crises. They are being called upon to encompass sophisticated technology and systems, when often their experience is of neither.

Unfortunately, as two recent reports (HANDY, 1987, and CONSTABLE and MCCORMICK, 1987) show, management development in the U.K. is extremely weak. This was basically the situation in the companies studied for this thesis: few interviewed managers had substantial management education either for management or for I.T. The starting point for this thesis was my concern about the education, training and development of managers in relation to the ubiquitous and powerful new technologies. The research clearly shows that tomorrow's managers will need a much improved understanding (and skills to match) of team management, of technology and of systems. Probably technology has always been seminal for organizations, but with I.T. it is now inescapable that management is deeply implicated in technological issues.

There is then, and this is important, a need to integrate an understanding of technology and its effects into all management and business education and training, not least for the most senior managers. Such education and training would at least include:
a. an appreciation of the several more important technologies such as I.T., biotechnology, opto-electronics, plastics and combination materials;

b. an understanding of the historical development of technologies and their economic, social and political consequences;

c. some focus on the contention between fast developing technologies, and cultural-structural-social inertia, and solutions to these contention problems, and

d. an extensive treatment of systems concepts and consequences for products and services, for organizational design and operations, and for tasks and jobs.

I believe the major contributions this thesis makes are:

1. An examination in some depth of the implications of I.T. on the work, roles and behaviours of managers, an area not previously extensively researched.

2. A rich overview of current managerial work in five unique cultures each with different extents of I.T. applications.

3. Viewing the interaction of I.T. and management from the important aspect of management education and development.

And finally. In the long run I.T. will probably have wrought radical changes on business. In the shorter run the ongoing transitions are multi-dimensional and fiendishly difficult to understand. Organizations and their managers are, it seems, becoming more technological, systematised and adaptive. But to quote again from the 1956 H.M.S.O. report on automation: "Automation will not make robots of us all. On the contrary it will demand wider knowledge, greater ability and a higher degree of skill from worker and manager alike".
## APPENDIX 1

### MANAGERS INTERVIEWED

#### 'ENGINEERING'

<table>
<thead>
<tr>
<th>TITLE (No. of Interviews)</th>
<th>FUNCTION</th>
<th>TIER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Financial Director (1)</td>
<td>Finance</td>
<td>2</td>
</tr>
<tr>
<td>2. Treasurer (1)</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>3. Manager, Computer Systems (3)</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>4. Manager, Finance Administration (2)</td>
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<td>3</td>
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<tr>
<td>5. Manager, Systems &amp; Programming (2)</td>
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<td>6. Assistant Treasurer (1)</td>
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<td>7. Manager, Accounts Payable (1)</td>
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<td>8. Manager, General Accounting Systems (1)</td>
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<td>9. Senior Project Leader (Finance Systems) (1)</td>
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<td>10. Senior User Systems Planner (1)</td>
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<td>11. Manager, Provisions &amp; Payroll Administration (1)</td>
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<td>12. Manager, Organization &amp; Methods (1)</td>
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<td>13. Supply Manager (1)</td>
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<td>14. Purchase Agent (1)</td>
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<td>15. Manager, Material Scheduling &amp; Inventory Control (1)</td>
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<td>17. Traffic Staff Manager (1)</td>
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<td>18. Manager, Traffic Planning &amp; Operation (1)</td>
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<td>19. Administrative Assistant to Marketing Director (2)</td>
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<td>20. Manager, Marketing Services (1)</td>
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- 309 -
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<td>1. Managing Director</td>
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<td>3. Systems Development Manager</td>
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'HARDWEAR'
14. Manager, Manufacturing Systems (2)  "  4
15. Manager Factory B (1)  "  4
16. Manager Factory C (1)  "  4
17. Director of Domestic Marketing & Sales (1)  Marketing 2
18. Manager, General Sales (1)  "  3
19. Manager, Commercial Systems (2)  "  3
20. Manager, International Distribution (1)  "  3
21. Manager, Domestic Sales (1)  "  4
Also several informal conversations with:
Training Manager
Manager, Market Communications

'FASHION'

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Also several informal conversations with
Managing Director
Other Factory Managers

- 311 -
### 'INTEGRAL'

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### 'COMPONENTS'

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5. Manager, Manufacturing A (1)  
6. Manager, Manufacturing B (1)  
7. Planning Manager (1)  
8. U.K. Marketing Manager (1)  
9. European Marketing Manager (1)  
10. Product Marketing Manager A (1)  
11. Marketing Operations Manager (1)  
12. Product Marketing Manager B (1)  
13. Systems & Services Manager (1)  
14. Personnel Director (3)  
15. Personnel Manager A (1)  
16. Personnel Manager B (1)  
17. U.K. Facilities Manager (1)  

Also several informal conversations with Personal Assistant to Personnel Director.
### APPENDIX 2 : INTERVIEW FORMATS

(Format 1 was used in discussions with other researchers) RESEARCH 14.10.84 JMJ/MPMS

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>Analysis Sheet Completed</th>
</tr>
</thead>
</table>

**INTERVIEW FORMAT 2**

(Used for pilot interviews)

1. Name of Manager
2. Title
3. Internal Phone
4. Qualifications
5. Experience

6. Current Responsibilities

7. Skills/knowledge re IT - What IT Courses have you attended?
8. What knowledge/skills on IT do you have? (Beyond Awareness)
9. What do you feel about IT?
10. How would you characterise IT in this company?
11. Who are the key people in this company for IT?
12. Which departments are developing IT fastest?
13. What IT applications are you currently involved with?
14. How is IT strategy determined?

15. Why are these applications taking place?

16. Where does push to use these applications come from:
   - Management above?
   - Interviewee?
   - Staff below?
   - DP staff?
   - Other managers

17. Are applications analysed post event?
18. What % of your own role is now somehow IT/systems related? Explain

19. What other management roles have reduced?

20. How do you expect IT/systems to develop in or around your role?
21. Is your role changing because of IT?

How and why?

Checklist

IT Knowledge
Emphasis on

- people
- data
- technical
- equipment

Authority
Responsibility
Clarity of role
Initiative taking
Boundary Xing
Time span of discretion
22. Are you altering the structure or processes within your sphere of responsibility because of IT? How and why? Be specific.

Checklist

Section organisation

Number of managers/supervisors

Number of professionals

Total number of staff

Vertical tiers

Delegation

Decision making

People reporting to you directly

Communication (within section)

Clarity of tasks - specialisation

Training
23. How are the structures/processes changing between your section and the rest of the company as a result of IT?

<table>
<thead>
<tr>
<th>Checklist</th>
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<tbody>
<tr>
<td>Functional demarcation</td>
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<td>Data flows</td>
</tr>
<tr>
<td>Decisions</td>
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<tr>
<td>Communication</td>
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<tr>
<td>Clarity of tasks</td>
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<tr>
<td>Flexibility/rigidity</td>
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<tr>
<td>Ownership of data</td>
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<tr>
<td>Top management interventions</td>
</tr>
</tbody>
</table>
24. How is IT changing the knowledge/skills you require to be effective?

25. Is IT/systems being developed too slowly/too fast in your section? Why is this? What are you doing about this?
IN DATA BASE

1. Name of Manager
2. Title
3. Internal phone
4. Office location
5. Qualifications
6. Experience
7. Current responsibilities
8. Tier number (MD=1)
9. Number or people reporting to you directly
10. Classification of subordinates and changes in the last 5 years

Managers
Professionals
Skilled Clerical
Unskilled Clerical
Skilled Manual
Unskilled Manual
11. How does IT affect your job?

Prompts:

Micros
Systems
Data

12. Why is IT being used more in your area?


Prompt:

VDU/Terminal
14. How do you use your time? Is this changing due to IT?
Prompts:
- Routines in role
- Flexibility
- Initiative taking
- Activity pace
- Decisions

15. What people issues do you get involved with? Any changes related to IT?
Prompts:
- Relations w/ staff
- Collegiate vs hierarchy
16. What systems or data issues do you get involved with? Any changes because of IT?

Prompts:

- Timeliness of data
- Clarity of data
- Access to data - self
- Access to data - subordinates
- Amounts of data
- Control of data
- Systems design
- Systems improvement
- Systems links w/ other depts
- Systems links outside company

17. What other depts do you most relate to? How? Why? Is this changing because of IT?
18. What planning do you do?
   Prompts:
   Time for reflection
   Time horizons
   Strategy

19. How are you preparing for the future?
   Prompts:
   Current knowledge of IT
   Own training
   Staff training
For each question (5 to 38) managers were asked to compare their present job situation to that pertaining five years previously and to tick a 5 tone scale:

<table>
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<th>Increased</th>
<th>Decreased</th>
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<td>Stayed the same</td>
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<td>20%</td>
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In the subsequent analysis these tones were rated 9, 7, 5, 3 and 1 respectively for 1, 2, 3, 4 and 5.

Thus the following figures show approximately the degree of increase (above 50), or decrease (below 50) in each subject as perceived by managers. For instance the answers to question 9 (clustering around 70) suggests a perception of considerably increased quantities of information.

Notes:

1. \( B/C = \) 'I.T.-involved' managers.
   \( D = \) 'less I.T.-involved' managers.

2. Specialist I.T. managers are excluded from both groups. Thus overall rating is not necessarily the mean of B/C and D ratings.

3. At 'Components' it was not possible to discriminate B/C and D managers.

4. The full questionnaire formats are at Appendix 4.
<table>
<thead>
<tr>
<th>Category</th>
<th>B/C</th>
<th>Overall</th>
<th>B/C</th>
<th>Overall</th>
<th>B/C</th>
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</table>

**5.** My time charter Information has

**6.** Paperwork in my job has

**7.** My involvement with Information has

**8.** The usefulness of printed Information

**9.** The quantity of Information which I use in my job has

**10.** The access of my Immediate Subordinates to the Information available to me

**11.** The difficulties in understanding the Information I get have

**12.** The usefulness (in applying to time to

**13.** The time charter (b) is decreased (by 20%) in the degree of increase (above) the degree of increase approximately

**NOTE:** The figures show approximately
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<td>00 60 63 63</td>
<td>48 52 63</td>
<td>48 50 48</td>
<td>58 53 48</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>96 63 76 48</td>
<td>55 52 63</td>
<td>40 44 43</td>
<td>40 44 48</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>96 80 56 46</td>
<td>67 50 69</td>
<td>46 55 46</td>
<td>58 35 54</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>96 73 56 64</td>
<td>78 82 73</td>
<td>71 70 71</td>
<td>61 53 61</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td></td>
<td>59 69 63 96</td>
<td>69 65 96</td>
<td>59 98 69</td>
<td>69 98 59</td>
<td>69</td>
<td></td>
</tr>
</tbody>
</table>

The table lists data related to various categories and percentages. The text above the table is not clearly visible due to the image quality.
QUESTIONNAIRE- 'A'

Thank you for helping with this research. It is trying to discover how managers' roles are changing.

"IT" = information technology = computers + systems + telecommunications + automation.

Company .................................................................

1. (a) Your name (capitals) ........................................... Your Age ....
    (c) Title ............................................................... Years in this post ....
    (d) Your qualifications (academic and professional) ....................

    ........................................................................

    ........................................................................

    ........................................................................

    (e) Your current responsibilities very briefly ............................

    ........................................................................

    ........................................................................

    (f) Your tier number now (Managing Director = 1) ......................
        (Managers reporting to MD tier = 2)

    (g) Your tier number in 1980 ..............................................

2. Number of people reporting to you now directly .......................

3. Total number of people for whom you are responsible ................

4. Classification of people for whom you are responsible and changes in numbers of these people in the last 5 years, i.e. compare your present section/department with the same section/department 5 years ago.

<table>
<thead>
<tr>
<th></th>
<th>Number Now</th>
<th>Approx No in 1980</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managers or Supervisors eg Warehouse Manager, Sales Administrative Supervisor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professionals eg Qualified Accountants, Qualified Engineers (without management responsibility)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skilled Clerical (probably not professionally qualified)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unskilled Clerical eg filing clerk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skilled Manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unskilled Manual</td>
<td>331</td>
<td></td>
</tr>
</tbody>
</table>
Please tick appropriate box. Comments refer to your own job in your own organisation. Compare the present with 5 years ago.

### A  Information Issues

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20%</td>
<td>2</td>
<td>10%</td>
<td>3</td>
</tr>
<tr>
<td>5. My time chasing information has</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Paperwork in my job has</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. My involvement with information gathering, analysis and dissemination has</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. The usefulness of printed information available to me has</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. The quantity of information which I use in my job has</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. The access of my immediate subordinates to information available to me has</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. The difficulties in understanding the information I get have</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. The &quot;timeliness&quot; (= arriving in time to be useful) of information available to me has</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### B  Subordinates (to my present function)

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Number of subordinates reporting to most of my 1st line supervisors has</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. The number of professionals and skilled people amongst my subordinates has</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. The &quot;management of people&quot; content of my immediate subordinates has</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Please tick appropriate box. Comments refer to your own job in your own organisation. Compare the present with 5 years ago.

<table>
<thead>
<tr>
<th>B Subordinates (Continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16. Time spent talking with my immediate subordinates has</td>
</tr>
<tr>
<td>17. My time on &quot;people&quot; issues has</td>
</tr>
<tr>
<td>18. The problems of getting skilled staff has</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>19. My involvement with systems/computers has</td>
</tr>
<tr>
<td>20. My knowledge of computers/systems has</td>
</tr>
<tr>
<td>21. My use of electronic data bases has</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D Your Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>22. My involvement in industrial relations issues has</td>
</tr>
<tr>
<td>23. My authority to take decisions has</td>
</tr>
<tr>
<td>24. The complexities in taking decisions has</td>
</tr>
<tr>
<td>25. My emphasis on strategy (as distinct from short term tactics) has</td>
</tr>
<tr>
<td>26. My amount of consultation with managers senior to me, has</td>
</tr>
</tbody>
</table>
Please tick appropriate box. Comments refer to your own job in your own work organisation. Compare the present with 5 years ago.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20%</td>
<td>2</td>
<td>10%</td>
<td>3</td>
</tr>
<tr>
<td>Increased</td>
<td>Increased</td>
<td>Stayed the same</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
</tbody>
</table>

**D Your Role (Continued)**

27. The formality in my role has

**E Use of your time**

28. Time spent dealing with other departments in my company has

29. My time spent on routine activities has

30. My time for reflection has

31. The pace of my job has

32. The time ahead (in weeks) that I focus on mainly has

**F Organisation Matters**

33. The organisational influence of the company's computer department has

34. The number of tiers of management in my company has

35. The difficulties in knowing who I should communicate with (in my company) have

36. The understanding of my senior managers, of work done in my section, has

37. The number of rules and regulations in my job has

38. The "planning" elements in my role have
QUESTIONNAIRE 'B' - COMPANY DATA

The purpose of this questionnaire is to establish the size of your company, and any changes in size, and to give an idea of your products.

Thank you for helping in this survey.

1. Company name

2. If the company is part of a group would you briefly explain:

3. Total UK Employees

4. Total Employees in this location (Approx)

<table>
<thead>
<tr>
<th></th>
<th>1985</th>
<th>1982</th>
<th>1980</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Total number of managers (excluding supervisors) at this location

<table>
<thead>
<tr>
<th></th>
<th>in 1985</th>
<th>in 1980</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Total number of supervisors (in addition to managers) at this location

<table>
<thead>
<tr>
<th></th>
<th>in 1985</th>
<th>in 1980</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Total sales revenue from this site

<table>
<thead>
<tr>
<th></th>
<th>1984</th>
<th>1982</th>
<th>1980</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. Product Range

PLEASE RETURN TO

John Moss Jones
Head of Dept. Management Centre
Luton College of Higher Education
Putteridge Bury
Hitchin Road, Luton, Beds.

(0582) 34111
QUESTIONNAIRE 'C' - INFORMATION TECHNOLOGY

IT = computers + systems ; automation ; telecommunications

The purpose of this questionnaire is to establish the factual history of the development and use of information technology in your company. Looking back over that history, can you identify different 'periods' in the use of computers (etc) - for instance based on different hardware, or on adopting new systems. Assuming you can divide these developments into a number of 'periods', would you fill in one of these forms for each period.

1. Company ..........................................................

2. Brief description of the period

3. Approximate dates of that period ................................

4. Main computer/s (types) at that time ........................

5. Principal applications of the computer at that time.

6. Number of people in data processing operations in that period ........

7. Operations mode of your computer during period.
   % batch entry ....................................................
   % remote job entry ............................................
   % on-line .........................................................

8. Numbers of (at this location only).
   8.1 Personal computers/micros .................................
   8.2 Terminals other than main computer .....................
   8.3 Mini computers other than main computer .............
   8.4 Management work stations .................................
   8.5 Word processing stations .................................

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8. continued ......

8.6 CAD displays ..................................................

8.7 CNC machines on shop floor ..............................

8.8 Robots ......................................................

8.9 Other ........................................................

9. If you would like to add your own comments about this period, that would be helpful.

Thank you for your help.

PLEASE RETURN TO

John Moss Jones
Head of Dept. Management Centre
Luton College of Higher Education
Putteridge Bury
Hitchin Road
Luton, Beds

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