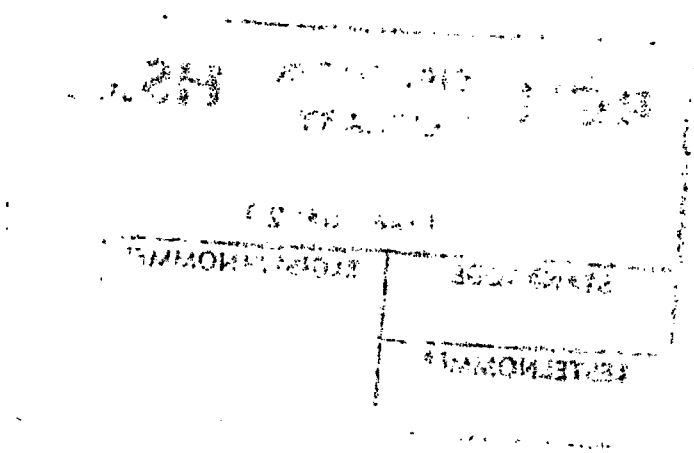
Programmable technology and the work done in manufacturing industries: An exploratory study



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Programmable technology and the work done in manufacturing industries: An exploratory study

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PREFACE

The introduction of computer-based technology into South African industries at the present time needs to be seen in terms of the two major manpower problems in this country. On the one hand, there is a number of unskilled workers competing for a slice of the shrinking market of unskilled jobs. On the other hand there is a lack of high level manpower which often means that people are placed in jobs for which they are underqualified. Computer-based technology, when introduced into this environment, can be used in quite different ways to those in which it is used in other countries. This exploratory report highlights some of the problems faced by industrial concerns and their workers in relation to the way in which this type of technology is being used.

The participants in the project are sincerely thanked for their valuable contribution. Sincere thanks are also expressed to the late Executive Director of this Institute, Dr. Steve Terblanche for his guidance throughout the project and his interest and enthusiasm.

ACTING EXECUTIVE DIRECTOR

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'n Gevallestudiebenadering is gevolg om die wyse te ondersoek waarop rekenaargebaseerde tegnologie in die vervaardigingsbedryf ingevoer word. Die aard van programmeerbare tegnologie asook die proses van verandering wat dit teweeggebring het word bespreek, soos gesien deur werkers en besture onderskeidelik. Nuwe vaardighede wat na aanleiding van rekenaargebaseerde tegnologie in die werkplek benodig word, is geïdentifiseer terwyl opleidingsbehoeftes ook bespreek word. Voorts is veranderings in die indiensnemingspatrone by die onderskeie deelnemende organisasies ook ondersoek. 'n Belangrike aspek wat in ag geneem is, is die wyse waarop veranderings na die werkers gekommunikeer is.

ABSTRACT

In this project, an exploratory case study approach was used to examine the way in which computer-based technology is being introduced into manufacturing industries. The type of programmable technology that is being introduced was described and the process of change set in motion by this introduction was discussed. Change was described from both the managements' and the workers' point of view. New skills that are needed in the workplace in relation to computer-based technology were identified and training needs were discussed. Changes in employment patterns in the participating firms were also identified. An important consideration that was taken into account was the way in which this change was communicated to the workers.

CHAPTER 1

BACKGROUND TO AND AIMS OF THE STUDY

1.1 INTRODUCTION

Technology is one of the focal points of social organization. The way of life, the economic activities and the state of technology in a given society at a particular time, have a reciprocal influence on each other. For example, the gathering of fruits and nuts and the exercise of hunting as primary economic activities and the small band as a social unit, are based on a more primitive state of technology than the economic activities and social structures of a settled community involved in farming. Hunting and gathering are compatible with a life-style which is completely different from that which is compatible with farming.

More sophisticated technology leads to the introduction of new economic activities, to greater diversity in the work done and new ways of life. The introduction of cottage industries into the homestead of the farm turned the farm into a self-sufficient economic unit. Then, the development of manufacturing industries in factories concentrated in central areas near the source of power, which went hand in hand with the development of the steam engine, again meant a different way of life. Home industries were compatible with a rural life-style. The factory system directly influenced the development of modern urbanization.

Technological innovation brings about profound social change. Consider the following methods of grinding wheat: the use of human muscle power, of animal muscle power and then the harnessing of the power of water and wind through the use of mills. Each method can be used to carry out the task but some methods are more efficient

than others. This increase in efficiency has freed people from being preoccupied with mere subsistence and has allowed them to move towards a more diverse usage of time, thus totally changing social organization. The development of each new technology and each new source of power (the steam engine and the internal combustion engine, the harnessing of electricity, the development of electronics and miniaturization leading to modern-day microchip technology) has led to further development of societies, to more specialization and to new ways of life. Change has however not always been smooth and upheavals in one section of society affect other sections.

The fears of the Luddites of mass unemployment spring to mind in any consideration of the effects of technological change on the worker and on work. The name Luddites was given to the nineteenth century organized bands of English craftsmen who rioted because they feared that their jobs would be lost. During the Industrial Revolution, the introduction of the Spinning Jenny changed weaving methods rather drastically. Ned Ludd led a revolt against this change during which some of the new machinery used for spinning and weaving, was destroyed. Riots became widespread and continued sporadically between 1811 and 1816 (Encyclopaedia Britannica, 1975). The actions of the Luddites were vigorously repressed but were not completely eliminated. Riots in the South of England from 1830 to 1831 led to the destruction of 500 threshing machines by agricultural workers who feared that their jobs would be lost if they did not resist the introduction of the new machines (Freeman & Soete, 1985). Increased prosperity, coupled with active repression, eventually brought an end to the movement. Just how realistic were these fears of job loss?

With hindsight one can say that structural changes in employment patterns did take place. Many peasants, craftsmen and labourers did lose their jobs. On the other hand though, many new jobs were created. Some of these new jobs were extremely stressful, monotonous and boring. The unskilled labourers in the mines endured a great deal of hardship and suffering. So did many of the unskilled work-

ers in factories. On the other hand, challenging new jobs, such as those of the engineer, were created. The age of craftsmanship, where the craftsman was responsible for the total production process, had ended. Mechanization required a complete reorganization of the methods of production. The work had to be divided into a series of well defined steps. Analytical methods were thus introduced. More diverse and specialized skills were required.

The actual occupational structure changed; this led to changes in social structures. Relocations of people from the countryside to urban areas took place on a massive scale. The small family unit consisting of father, mother and children replaced the extended family, partly because it is a more mobile unit than the extended family and therefore economically more viable in a metropolitan environment.

These dramatic changes were not foreseen by the Luddites who only focused on one aspect of change, namely employment. This narrow view may be taken as a warning of the pitfalls to be avoided by modern researchers studying the effects of further automation. Computer based technological innovations will introduce change which will have far reaching effects globally.

The introduction of micro-electronics into industrial manufacturing processes is still in its initial stages in South Africa. The effects of this new technology are only beginning to be understood. The number of computer controlled machines in use in industry is still relatively small. Industry in general tends to be relatively more labour intensive when compared to the capital intensive trends of Western countries, and computer-based equipment is less frequently used. In spite of this relatively infrequent use of computer based machinery and equipment, it is vital to study how programmable technology influences the work situation in those manufacturing industries where the new technology has been installed. Some of the consequences of the introduction of this new technology can be better understood by investigating how it is being used by

early adopters; suggestions for more orderly change can be made before its use becomes more widespread. Human needs in the workplace can more easily be taken into account if an understanding of these needs in relation to the new technology, is based on empirical observations.

In future, if the trends in South Africa follow those of other industrialized countries, computer based manufacturing technology will become increasingly popular. As more firms realize that competitiveness is negatively affected if the new technology is not used, they are increasingly likely to try out the new computer based methods of production. It seems reasonable to state that, in this country, programmable technology will be applied more and more to manufacturing processes.

1.2 PROGRAMMABLE TECHNOLOGY

The terms "programmable technology", "computer-based technology", "microchip technology", "programmable automation" and "computerization" are used interchangeably in this study to refer to those machines and equipment used in manufacturing industries that are regulated or controlled by microchip technology or by other computer based means. These terms do not refer to the electromechanical processes which have been in use in manufacturing processes for some time and are still in use. Conveyor belts and the assembly line method of production are examples of technology that have been extensively used for a long time and are still used. The incorporation of a microprocessor into a piece of machinery, or the use of other forms of computer technology in machines so that they can be programmed to perform certain tasks, adds flexibility to the manufacturing process because the functions of programmable machines can be altered by changing the information that is fed into them. They are flexible in the sense that it is not necessary to carve new cams and gears and rebuild the machines with new parts to make them do different work (Winkless, 1984).

Computer-based technology may be causing profound change regarding the type of work which can be done by machines and the type of work which will then be done by people.

There are other innovations and other new processes besides programmable technology which are also altering manufacturing processes, and hence, the work done by people in the manufacturing industrial sector. For example, use made of biotechnology, of fibre-optics, of polymers and other synthetic materials for a variety of products, is changing manufacturing processes. It is however not possible to study all aspects of new technologies and their influence on the work situation in a single project. This project is limited to the study of the effects of the use of computer based technology in the manufacturing industries on the worker and the type of work done in these industries.

1.3 AIMS OF THE STUDY.

This study is essentially exploratory in nature. It aims to find a group of early adopters of programmable technology, and to examine their experiences with regard to the installment and use of the new computer based methods. The attitudes of the early adopters will influence the rate of adoption and the use to which the new technology is put by later adopters. Predictions based on the experiences of early adopters can then be made concerning the possible effects of computerization on the labour force and on the nature of work. These predictions may be useful to planners in helping to minimize any disadvantages and in helping to maximize any advantages for the worker and the organization of work as the use of programmable technology spreads. They may also be useful to career counsellors and in helping people make realistic career choices. Educators and trainers can also benefit from these findings.

This study therefore aims:

(a) To describe the type of computer based technology that is being introduced into a small number of manufacturing industries in South Africa at the present time, and how this technology is being used;

(b) To describe the possible effects of this new technology on

(i) the content of work

(ii) the composition of the work force

(iii) new skills requirements

(iv) the training and retraining needs of both management and workers;

(c) To describe the effects of this new technology on employment opportunities which may be created or lost in the manufacturing sector;

(d) To describe the advantages and disadvantages of programmable technology as perceived by management;

(e) To describe the advantages and disadvantages of computer-based technology as perceived by the workers;

(f) To discuss what, if any, consultation processes took place between management and workers prior to and after the introduction of the new technology and its possible impact on industrial relation and collective bargaining.

The findings of this report can be useful to both the vendors of programmable technology and to those firms planning on installing it. Both these groups can learn from the experience of other what the advantages and the pitfalls of the introduction of this type of technology are.

1.4 THE NATURE OF INNOVATIONS AND DISCOVERIES

Inventions and discoveries can be divided into two groups. Firstly there are those that are truly original, in that a totally new product or process is introduced. The invention of the steam engine is a good example of how manufacturing processes and transport systems changed by harnessing a new source of energy. Secondly, there are refinements and modifications of existing technology and adaptations of it for new uses. The invention of the internal combustion engine led to the development of the motorcar and refinements of the car have been taking place since its introduction.

Both innovations and refinements are based on the state of knowledge that exists at that particular time. Neither innovations nor their refinements occur overnight. They rely on an accumulation of previous technologies and previous knowledge in the field. Their acceptance takes place over a period of time.

1.5 THE ADOPTION OF INNOVATIONS

Very few individuals or organizations who can make use of an innovation do actually adopt the new idea or technology immediately at the time when it is first introduced. A process of diffusion takes place. This process has been described as one consisting of the following elements:

(a) A new idea, invention or innovation;
(b) A group of people or of organizations who can make use of the innovation;
(c) Channels of communication to make the innovation known and
(d) A period of time or a time sequence between that of the initial introduction of the new dimension and that of the adoption of the innovation by most of the potential users (Rogers, 1983).

A typical S-shaped curve has repeatedly been found to be associated with the rate at which an innovation is adopted. The variation in size and shape of this curve is influenced by various factors.

On a societal level the readiness of a society to accept change is one such consideration. Openness to change depends in part on the state of knowledge in a given society and familiarity with the technological development preceding the innovation. The skill level of the work force, of both managers and industrial workers, will influence whether or not the understanding of the applications of the new technology that is relevant to a particular industry, is present. This understanding, or lack of it, influences the rate of adoption. The way in which programmable technology is marketed will also influence the rate of acceptance. Vested interests in the old or the new technologies may also influence the rate of change. For example, certain innovations may be suppressed because large sums of money have been spent on competing innovations.

On an individual level the reactions of people need to be taken into account. Fears of job losses or fears of problems which may manifest themselves after the installation of programmable technology may affect the rate of adoption. The positive or negative experiences of initial users will also guide the future implementation. The more positive the experiences of the initial users, the faster the rate of adoption is likely to be.

There are various adopter categories to be found among individuals or organizations who can make use of a new invention, namely the innovators, the early adopters, the early majority, the late majority and the laggards (Rogers, 1983). Indeed some people never adopt new technology, hence there are people who have never learned to drive a car. At any stage of adoption of an innovation, a state of cultural lag develops between the adopters and the non-users of the new invention. During this stage, uncertainty is experienced by both users and non-users particularly if the change induced by the innovation is perceived as a major one. This uncertainty can act

as a creative and constructive, or an inhibitory and destructive force, depending on the way in which the innovation is used and on the social change that occurs, if the consequences of the innovation are taken into account.

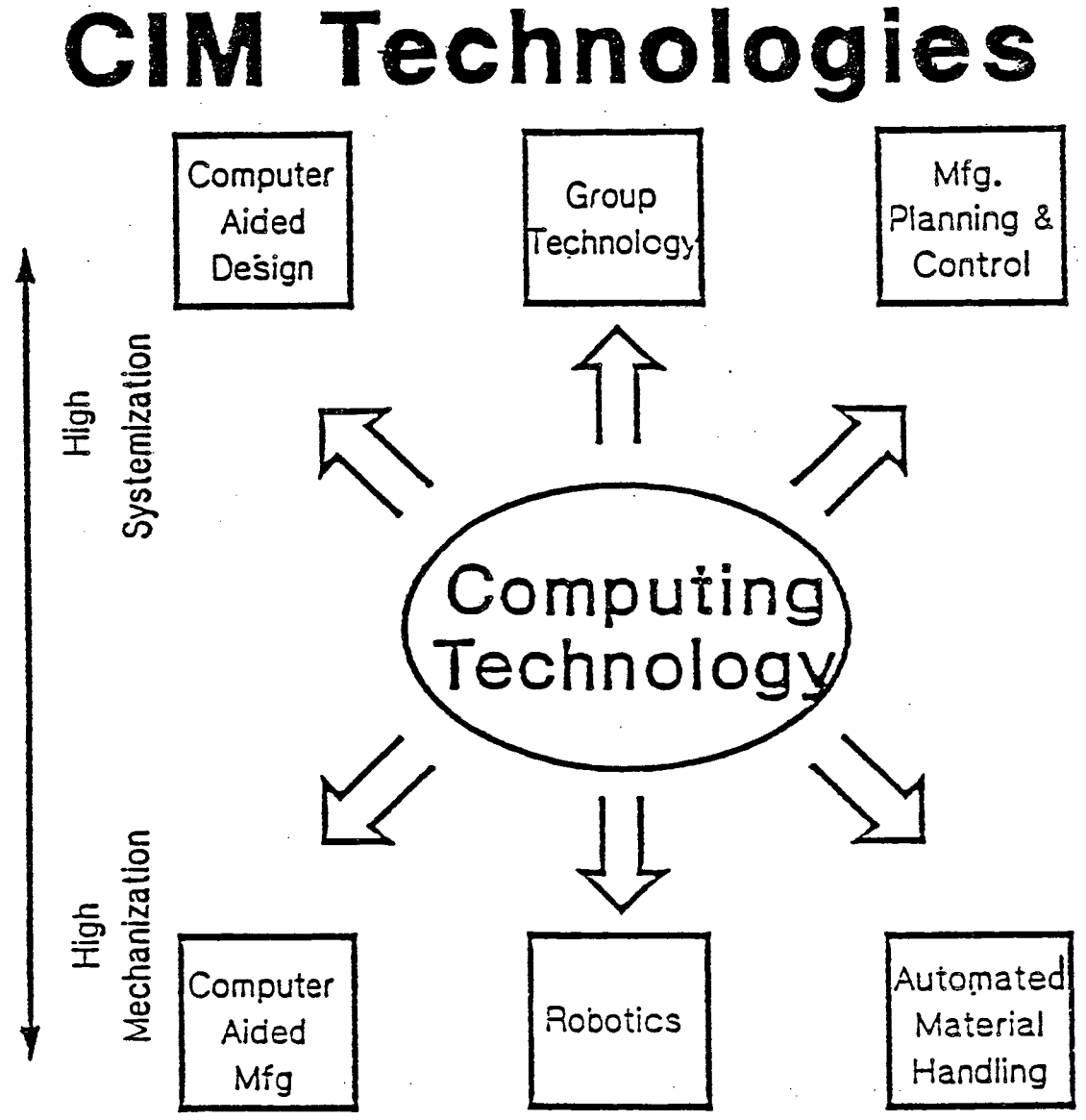
1.6 TECHNOLOGICAL SYSTEMS

Any invention on its own does not necessarily cause dramatic social change. Only when inventions are joined together to form a system is the impact strongly felt. For example, during the industrial revolution, the introduction of one steam engine into a workshop did not cause any dramatic change. The effects on the worker were hardly felt. It was only when the various technologies were interlinked that the effects of the new technology became more evident. In the industrial revolution, linking the steam engines of the factories with those of the new transport systems brought about profound change. Methods of production and methods of distribution were both more compatible to the new requirements of an industrial age where factories were replacing home industries.

This idea of the linking of technologies into systems is an important consideration when examining what is happening in South Africa at present. The introduction of one industrial robot into a factory may not have any marked effect on the work situation of the majority of workers. Only when computer-integrated manufacturing (CIM) takes place on a large scale, will the full effects be felt. Aspects of computer-integrated manufacturing are illustrated in Figure 1. This type of manufacturing (CIM) is defined as a "strategic framework for linking existing technologies and people to manage previously independent activities to achieve a total manufacturing system". (This is a definition used by the Hewlett-Packard Company.) The linking of microcomputer technology that is used in actual manufacturing, computers used by management for stock control, for taking orders and for despatch, for example, is the beginning of a system of interconnected networks. When computer connections are established between the machines of the shopfloor

and the management information systems of firms that do business with each other, then the change will become more evident. New patterns of communication, new work patterns and social change will then become inevitable.

FIGURE 1



KEY: Mfg = Manufacturing

(Diagram obtained from Hewlett-Packard)

In South Africa at present computer based management systems are in the process of being introduced into manufacturing industries. These can be linked to the computer based manufacturing equipment and machines to form an integrated manufacturing system. Materials requirements planning (MRP) and just-in-time (JIT) systems are examples of this type of new management technology which attempts to give the industrialist better control over manufacturing processes. These can be linked to the microchip based machines used in manufacturing, so that information concerning what is happening in the workshop can be directly fed to management, and ordering new material for example, can be directly linked to existing needs in the factory.

Another example of technology which links two processes together, is that of computer aided design which can be directly connected with computer aided manufacture (CAD-CAM systems). The design and manufacturing elements are no longer separated from each other in such a system and each can function more efficiently as a result of interdependence.

This linkage of the various aspects of technology used in manufacturing systems is being carried out on a relatively small scale in South Africa at present. As it gains momentum, the linkage of manufacturing processes into systems can have profound effects on all levels of workers, from the unskilled labourer to the managing director. Each will need to learn new skills.

1.7 HOW THE PARTICIPANTS WERE OBTAINED

A complete list of all manufacturing companies that have installed micro-electronic equipment does not exist. Therefore it was not possible to draw a sample, which in any way represents those companies who have installed this type of technology, to participate in the study. Information was obtained by means of case studies conducted in certain metal manufacturing companies. Seven firms that had introduced computer-based technology, for example robots, com-

puter numeric controlled machines, flexible manufacturing systems and computerized systems of management took part in the project. These companies were selected on the basis of the sophistication of the technology they had installed. A description of the effects of the progression from simple to advanced use of this technology was the aim behind the selection of the firms that took part in the study.

These participants were obtained from the following sources:

(a) Firstly, the vendors of this technology were contacted and consulted regarding the construction of the interview schedule. They were also asked to supply lists of companies that had installed the new equipment who could be contacted to participate in the study.

(b) Secondly, a list of delegates at the 1986 annual congress of the South African Production and Inventory Control Society was obtained from that society, and certain delegates who were working for companies in the Pretoria-Witwatersrand areas and who had attended the congress, were contacted.

(c) Thirdly, the names of some companies who had installed the new technology were obtained from technical publications, namely "Engineering News" and "Computech" (Computer Technology for South African Industry). Newspaper articles were also used to locate possible respondents.

The participants can be regarded as early adopters on the grounds that they saw themselves in this light.

1.8 METHOD OF INVESTIGATION

The case study approach was used to describe the effects of technology on individual firms. Case studies allow one to obtain a picture of how change is affecting one or even a few organizations,

but it is not possible to build up a quantitative picture of what is happening in the entire country on the basis of individual experiences. It is however possible to obtain an indication of certain trends, although the conclusions that may be drawn are tentative.

1.9 THE INTERVIEW SCHEDULES USED

After consultation with various vendors of computer based manufacturing equipment, with lecturers in engineering faculties at universities, with researchers engaged in finding applications for industrial robots and with an economist, two interview schedules were constructed.

The first one was designed for interviewing people in management. The person most competent to discuss computer based technology in a particular firm was interviewed. The respondent could be either the owner-manager, the personnel manager, an engineer, the production manager or the training manager. Knowledge of computer based equipment was the most essential asset required. Sometimes information from more than one manager in a firm was obtained.

This interview schedule is given in Appendix 1. It covers a wide range of topics as it is not possible to know beforehand which aspects would yield useful information and which would not. A number of areas were covered.

(a) The type of establishment being interviewed, the products it manufactures.

(b) The work activities carried out by the firm and the amount of time spent on these activities.

(c) The number of people employed by the firm and the types of jobs available.

(d) The type of tools and machinery used for each work process and whether or not this equipment is programmable.

(e) How the decisions were taken to introduce the new equipment.

(f) The type of programmable technology that has been introduced.

(g) Any problems which may have been experienced regarding installation, programming and maintenance of this equipment.

(h) How the post structure has changed since the introduction of the new technology.

(i) The new skills which may be required as a result of the introduction of this new technology.

(j) New training and retraining needs necessitated by this programmable equipment.

(k) How the change was communicated to the workers.

(l) The advantages and disadvantages of the new technology.

(m) Future plans regarding the further introduction of programmable technology.

In other words, information was sought on the kind of technology which had been introduced, how successful this introduction was and the effects it has had on the work force.

The second schedule was designed to be answered by employees. It was hoped to obtain people actually working with the new equipment as well as people working with conventional equipment, but doing a similar job to that which was being done using the new machines. For example, welders using conventional welding equipment and robot

operators operating robots programmed to carry out welding tasks, were sought.

This second interview schedule, given in Appendix 2, covered the following areas:

(a) A description of the occupation, work activities and machinery and tools used by a worker to do his work.

(b) The skills and knowledge he requires to do his work, and how these have changed since computer based equipment was introduced into the workplace.

(c) The initial training the worker received to do his job, and any new training he has received since the introduction of the new technology.

(d) The way in which the change was communicated to him.

(e) His feelings towards the new technology.

(f) His opinions on how the work has changed since the introduction of computer based technology.

In other words, the opinion of the worker was sought on how programmable technology had influenced the work required of him.

Unfortunately it was not always possible to interview the workers. At the time of the study the trade unions were becoming increasingly involved in various issues affecting workers, including the introduction of programmable technology into certain firms. There was thus a fear among management of causing possible problems and making the work force react negatively to the introduction of computer-based technology by asking the workers questions about it. Interviews with workers were therefore conducted only among those firms who allowed their workers to be interviewed.

The following chapters are arranged in such a way that they take the extent of computerization into account. In Chapter 2 a firm making use of one industrial robot is discussed. This is followed by discussions of firms making more and more use of new technology. The last three firms described, all make extensive use of computer based technology.

CHAPTER 2

USING AN INDUSTRIAL ROBOT

The Robot Institute of America defines an industrial robot as a "reprogrammable, multifunctional manipulator designed to move materials, parts, tools or specialized devices through variable programmed motions in the performance of a variety of tasks." (Ulrich, 1983, p.12). Robots are controlled by microcomputers. The configuration of the arms of the robot determines its movements. Each distinct type of movement that a robot can make is known as a degree of freedom. The number of degrees of freedom designed into the robot will influence the type of work it can do.

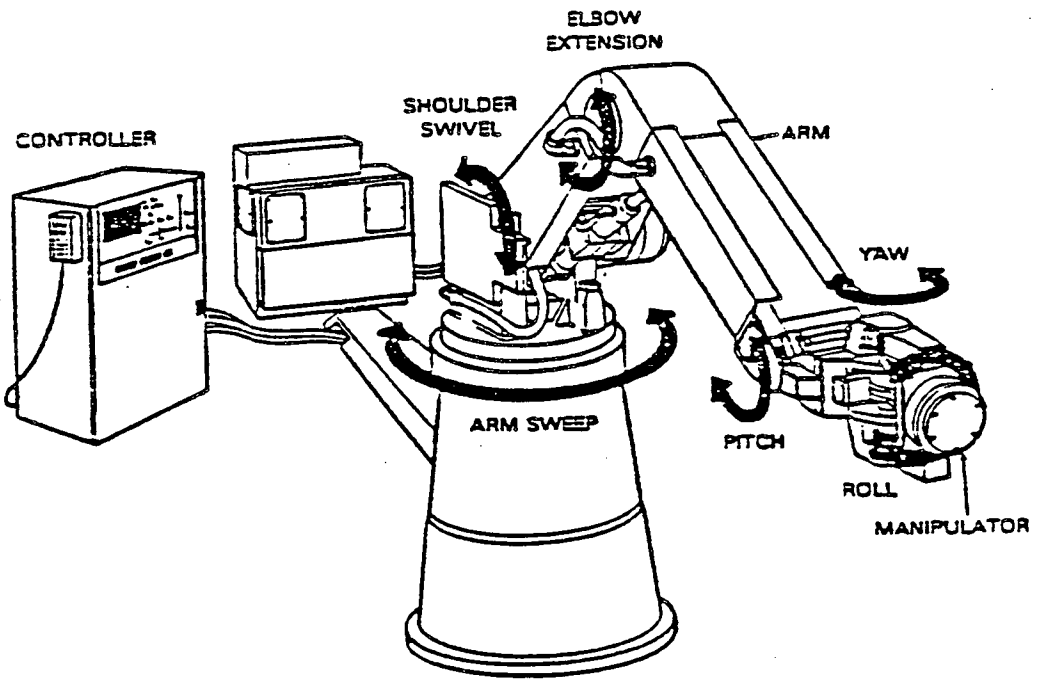
There are two different types of robot, the continuous path and the fixed point robot. Programming takes place, in continuous path robots, by leading the robot by its end effector (or hand) through the sequence of steps that comprises the task it is required to perform. Point-to-point robots allow the user to specify only the points between which the robot will move. The path taken between the points is determined by the robot. Robots can be equipped to sense heat, pressure, electrical impulses and objects in rudimentary form. Thus they can monitor the work they perform. A robot can perform many of the repetitive factory jobs at present usually being done by humans, for example, welding, spray painting and machine loading. These jobs tend to be dull, repetitive, unpleasant and sometimes potentially dangerous, and they provide relatively modest wages (Ulrich, 1983). Robots may decrease the need for direct labour but they may increase the need for indirect labour. Figure 2 illustrates the principal components of a robot.

2.1 THE WAY IN WHICH A ROBOT IS BEING USED IN A SMALL FIRM

An example is now given of how the installation of one industrial robot has influenced the work situation in one South African manu-

FIGURE 2

Principal Components of a Robot



Source: Shall, S., (1985) The Social Implications of Introducing Robots into Industry in South Africa.

facturing industry. A relatively small factory was involved. This example indicates the almost insignificant impact the installation of only one robot has on the work done in the factory as a whole. Nevertheless, it indicates how change begins to take place and how this change can escalate with the introduction of more robots.

The owner of this factory was also the manager. The factory manufactured motorcar components such as fans. The motorcar manufacturer for whom these components were being made, wanted the manufacturer to install the robot to make an item which needs highly accurate welds. They believed that the quality and consistency of the product would be better and meet overseas standards if a robot was used.

The factory employs 100 people of whom 87 are directly concerned with manufacturing, 10 are clerical staff and 3 are cleaners. Of the 87 workers directly involved in production, 2 are technicians, 6 are foremen and 10 are trained toolmakers (artisans). The rest are semiskilled or unskilled labourers, working as moulders, assemblers, operators, inspectors and checkers. One member of staff is responsible for maintenance of all machines.

Eighty percent of work time per month at this factory is spent on fabrication and assembly, 12% on management and administration. The rest (8%) of the time was spent on materials handling, design, storage distribution, repairs and servicing, negotiation and training.

There are no other computers or microchip based equipment in use in this factory. The owner, after consultation with the importers and vendors of the industrial robots, decided to install a robot which would best meet the needs of the motorcar company. The robot is responsible for 8% of what is manufactured in the factory.

By installing the robot, the owner-manager expected the following advantages:

- Manufacturing times would be shorter.
- A better product would be made.
- A more accurate weld would be obtained.
- Increased output would occur.
- Better efficiency would take place.
- There would be a saving on materials.
- The firm would be able to be more competitive.

The owner-manager did not expect that the introduction of the robot would lead to greater product options, as he did not plan to use its flexible capabilities. He did not intend to install the robot to eliminate dangerous jobs or to improve labour stability by replacing some workers with a machine. He installed the robot to perform a specific task.

The installation, programming and maintenance of the robot presented no insurmountable problems. The machine was installed by the vendor. A training package was provided at the time of installation but this proved to be inadequate. An outside engineering consultant had to be brought in to train the staff to use the robot. A skilled artisan who worked as a foreman was trained to programme, operate and maintain it. He can now carry out routine programming, operation and maintenance very effectively. The company has a service contract with the vendors to carry out major maintenance and servicing when necessary. Spares are easily obtained through the vendor.

As far as employment is concerned, very little change took place. One foreman was required to learn about the robot and its capabilities.

The manufacturer expressed the opinion that smallscale use of robots could be counterproductive, because of the large initial fi-

nancial outlay and the need for a technician to programme and use the machine.

The owner-manager is of the opinion that the use of robots will not lead to a replacement of skilled workers because there is at present a shortage of artisans in particular and of skilled labour in the country generally. For example, it is very difficult to find suitably qualified toolmakers and die-makers. The excess of unskilled workers is, in the opinion of this respondent, not due to automation but rather to the circumstances in the country which prevent everyone from contributing equally to the economy.

He further stated that it is dangerous to think that because there are too few job opportunities in South Africa, we should not make use of the new technology. Failure to do so would ensure that this country would fall behind the rest of the developed world, because products would no longer be competitive.

In reply to the questions on how skills have changed since the introduction of the robot, the respondent indicated that the foreman who worked with the robot had to learn how to programme, operate and maintain it. Although his artisan skills were not being directly used, he nevertheless needed them to enable him to instruct the robot. The foreman's job is therefore more skilled than it was previously. In general, the respondent felt that the introduction of robots could have two effects. On the one hand it could limit the need for certain skills, such as those needed in welding. On the other hand though it could introduce a whole new range of skills necessary to use the new technology.

The training to use the robot was not very complicated. The vendor gave the foreman welder a course which lasted one week. This was not quite sufficient, as an outside engineering consultant was needed to solve certain problems on how to use the robot for the specific purpose for which it was intended. He was also involved in training. On-the-job experience was needed in addition to the ini-

tial training so that the robot could operate as smoothly as possible.

One aspect regarding skills is that greater accuracy is now demanded of the unskilled worker in setting up the material which is to be welded. The preparation requires more careful attention than previously. The jigging-up must be extremely accurate for the robot to do its job as the robot cannot compensate for human error.

There was no consultation with the workers prior to the introduction of the robot. The owner-manager did not think it was necessary to tell the employees about it as it might have caused unnecessary tension. He stated that it was difficult to say how the workers reacted to the introduction of the robot as he did not ask them. It seemed to him that the robot was a source of amusement to the workers, rather than anything else.

When asked to evaluate the advantages and disadvantages of the robot, the most important general advantage mentioned was the better accuracy and the greater consistency of the finished product. The high initial outlay made it uneconomical in the short term but in the long-term, the robot should become an economic asset. As far as methods of production are concerned, the advantages are to be found in the saving on materials and the greater efficiency, while the disadvantages are to be found in the greater accuracy needed in preparation of the materials. As far as labour is concerned, the respondent felt that in future it would be an advantage not to have to rely so heavily on semiskilled workers,or to have to try to obtain scarce skilled labour. Robots, if handled properly, can eliminate human error. Productivity is greatly enhanced by the use of new technology and poor productivity in industry is one of the major problems in South African manufacturing industries.

As for future plans, the respondent intends to introduce office automation to eliminate tedious office work. He also intends to in-

troduce more robots. Therefore both clerical and manufacturing staff will be affected in future.

For this manufacturer trying out the new technology on a small scale led to positive gains. On the whole, it met his expectations.

2.2 THE EMPLOYEES' VIEWS OF THE EFFECTS OF ROBOT TECHNOLOGY ON THE WORK DONE IN THEIR FACTORY

Interviews were conducted with three of the employees. The foreman who programmes, operates and maintains the robot, is a qualified welder. He not only works with the robot, but he also supervises the work of other welders, most of whom are semiskilled labourers as they have not completed an artisan course. Besides his artisan training, this foreman had to learn how to programme and operate the robot, to maintain it and diagnose faults. As already mentioned, these new skills were initially acquired through attending a one week training course offered by the vendor. This respondent feels very positive about the introduction of the robot. Once it is set up, it leaves him free to carry out his other supervisory tasks. He feels that the new technology opened up a new field for him, making his work more interesting. The new technology increases the responsibility of the workers because extra care is needed in setting up the robot for operation. It makes more jobs available because it leaves people free to do other less routine tasks. It makes work less dangerous because the worker is not directly carrying out the dangerous task himself. Promotion opportunities are increased because new skills are learned. Stress on the worker is decreased and physical tasks are easier because the robot does all the tasks requiring lifting, carrying and moving into awkward positions. It also does jobs that are difficult to do manually. It improves productivity and overcomes inefficiency because it can work longer and faster than humans, without stopping. The robot improves standards of production because the quality of the weld is consistently good. With correct training, the robot is easy to operate and programme. General maintenance is relatively easy but

special skills are required for servicing. It increases scope for creativity because it expands education.

The second worker interviewed was a semiskilled welder who had not received artisan training and could not operate the robot. He also felt positive towards the robot because it did all the difficult tasks, hence making his job easier. He feels that machines do a better job than people and do not give any trouble. The robot is doing a job that is very difficult for people to do because of the awkward body position required. The robot does the difficult work, leaving the easier tasks for people to do.

The third worker, the person actually operating the robot, who sets up the material for welding, loads and unloads and cleans the machine, did however see some disadvantages in the use of the robot. He received one day's training from the foreman to learn the job. His previous job was that of spot welder. He was not consulted prior to the introduction of the robot but was just informed that his job had changed. He likes to use the robot because it offers the opportunity to learn new skills. He has been working harder since the introduction of the robot because he has to work faster. He perceives his work to be more dangerous than previously because he can easily get in the way of the moving arm of the robot. His job now requires more concentration. In general he finds it easy to operate the machine, but he does not think his job is very creative because the machine does the work. He would like to learn to programme it. He feels that robots will take jobs away from people because it can work much faster than people can.

This last respondent who had direct experience with the robot, was able to perceive some of the effects the wider use of robots may have on skills and employment. Nevertheless the encouraging experiences of both management and workers will lead to the introduction of further technology in the firm.

The experiences of this firm describe in microcosm the main findings in the literature. The work done by the robot is consistently more efficient than similar work done by humans, but the nature of the work done by humans changes. For some, new challenges are offered, whilst for others, work becomes less creative and less pleasant.

CHAPTER 3

THE USE OF PROGRAMMABLE TECHNOLOGY IN A SMALLER MANUFACTURING FIRM

The following firm to be discussed has introduced a few items of computer based equipment and machinery. As yet these are isolated components of technology as they are not linked together into a system. The installation of isolated new technology, rather than complete systems, seems to characterize its introduction in South Africa by the smaller manufacturing industries. Firms tend to try out one item. Then if they are satisfied, they introduce more new technology. There is little overall planning. More computer based equipment is however being used by this firm than the single robot being used in the previous example and more effects are noticeable.

One of the three managing directors of the firm was interviewed. This factory was manufacturing supermarket and other trolleys out of light metal. The firm also offers an after-sales and repair service to customers.

The firm had 81 employees, 9 of whom were involved in managerial, administrative and clerical work, and one of whom was a qualified engineer and was the production director. Six of the employees were involved in selling. The rest of the employees were used in the factory or the workshop, where they were involved in either the manufacture or repair of trolleys. Seven were foremen or supervisors, five were skilled artisans and one member of staff maintained the equipment. The remainder were either semiskilled or unskilled workers, such as operators, assemblers and inspectors.

At the time of the initial interview, all the workers were involved in a pay dispute. They had gone on strike and they were all fired and locked out by management. New people were being recruited and trained to fill the vacant posts. It was therefore not possible to

interview the workers. The information given applies to the situation before the strike and lockout.

Three computerized machines were being used for manufacturing, namely an industrial robot, a mesh plant and a bending machine - the latter two being computer numerically controlled (CNC) machines. These machines and their operation are discussed in detail in a later chapter. In addition a computer is being used for stocktaking and to send out accounts. This computer is not linked up to the factory operation. It is therefore not part of a computer-integrated manufacturing system (CIM). CIM includes not only the ability to control machine tools but it also enables information to be fed to management directly from the factory floor regarding material being used, stock available and how many orders have been completed, for example.

The work activities carried out at the firm are the following:

5% of time is spent on research and development;

5% on design;

40% on fabrication of products;

25% on assembly;

5% is spent on each of materials handling, storage, distribution of products, repairs and servicing; and

5% of time is spent on management.

The decision to install the new technology was taken by the managing directors who all hoped to gain similar advantages to those mentioned by the first respondent. In addition, they hoped to decrease the amount of supervision of workers, to increase record accuracy, to gain improved labour stability, to gain more product

options and increased output. Increased flexibility was also an important consideration. The factory could now make eight varieties of trolleys instead of the three they were making previously. The introduction of the new technology has allowed the firm to take a larger share of the market and to start exporting trolleys.

Assembly is done using conventional equipment as well as a computerized mesh plant; welding, by using conventional equipment as well as an industrial robot and bending by means of a numerically controlled bending machine. Inventory management is partly computerized.

The computerized equipment was installed to supplement existing machinery. Although a cost estimate was made before the new machines were installed there were many unforeseen costs. This applied particularly to the installation of the mesh plant. All the designs had to be redone as the old designs were unsuitable for numerically controlled equipment.

The vendor installed the equipment . There were no problems experienced with the actual installation but there were many initial programming problems. These were solved in consultation with the vendor, an outside engineering consultant and through experience.

Once these initial problems were solved, it was easy to change the programme for new processes. The company does routine maintenance on the robot and the bending machine, supplemented by a service contract with the vendors. The vendors of the meshing machine had however became insolvent, and the factory now has to take total responsibility for maintainance of this machine. Parts have to be directly imported from overseas when necessary. The support from the suppliers regarding maintenance is often inadequate.

The post structure of the firm changed as follows: sixteen extra workers have been employed. This is as a result of expansion of the company because technology has helped to make a more competitive

product. However the company plans to retrench some of the workers, as a result of the economic downturn at the time of the interview. High prices and small profit margins have had their impact. The respondent therefore felt that it is not the new technology, but the economic conditions in the country that are causing unemployment. This opinion was also expressed by the previous manager. After computerization, five semiskilled workers were promoted to supervisors and were used to operate the machines .

As far as skills are concerned, the employees working with the new technology, including the engineer, all had to acquire programming skills. The staff member responsible for maintenance needed an understanding of electronics as he needed to be able to detect mechanical, electrical and electronic faults. As in the previous example, unskilled workers were being used to load and unload these computer based machines. The manager felt that the work in the factory was routine and boring to most unskilled or semi-skilled workers, irrespective of whether or not they used the new technology.

His opinions concerning the lack of skilled workers and the need for new technology to replace skilled, rather than unskilled workers, were similar to those expressed by the previous manager. The present respondent stated that the new jobs being created by computerization are more skilled than the existing jobs, except for the job of robot operator which involves pressing a button and watching the process to see that nothing goes wrong.

Acquiring programming skills for robot operation was relatively easy. A week's course was again quite sufficient to acquire them. The CNC machines required more skills to handle them correctly. Any new recruit working with the new equipment will receive training internally, by supervisors on the factory floor.

The firm under discussion seemed to be aware of the need to inform the workers of the change as the supervisors were asked to show the

workers brochures of the new equipment and to explain to them how the new equipment worked before it was installed. However the workers were not consulted.

The respondent felt that the workers were all positive about the new technology as the work was less physically strenuous and the quality was a lot better. There were no negative reactions that he was aware of because nobody was laid off. The strike was in no way connected to the introduction of new technology, according to the respondent. Rather, the workers were striking for more pay and better working conditions.

As far as advantages of the new technology are concerned, the respondent felt that work was more consistent and correct, a better product was produced and hence the company became more competitive and had developed an export market. Surprisingly, among the disadvantages mentioned was what the respondent saw as the lack of versatility of the programmable machines. It takes a long time to set up the machines and it takes a long time to reprogramme them. Deliveries take longer because once the machines are set, they have to run their course, making it difficult to manufacture smaller batches. This opinion is contrary to the the claims of greater versatility of computer-based equipment made by their manufacturers. Automated inventory control has made office work much more efficient.

In future, this firm intends to introduce even more computer based technology in the form of more robots and meshing machines. They hope to be able to buy locally manufactured machines as this should save on costs and make it easier to obtain spare parts when necessary. A local company is planning to manufacture a suitable meshing machine in South Africa.

This example of the introduction of new technology into a workplace indicates how difficult it is to disentangle the effects that technology itself has on work from the other factors influencing change

in the workplace. The organization of work, the remuneration of workers and the working conditions in a factory, the economic stability in the country at a given time, the demand for a certain product and the efficiency of management, all influence change taking place in a work situation.

Unfortunately it was not possible to interview the striking workers. They were replaced by other workers and the industrial dispute was unresolved three months after the initial interview was completed. It would have been interesting, and highly relevant, to obtain their opinions on the extent to which the new technology played a part in their dissatisfaction.

CHAPTER 4

USING NUMERIC CONTROL OF MACHINE TOOLS IN A MEDIUM SIZED FACTORY

One of the most important current applications of micro-electronics in industrial processes is numeric control of machine tools. All types of metal working tools can be controlled by this type of technology which can supplement or replace hydraulic or plugboard control or control of machine tools by cams. Numeric control of machine tools was originally introduced for small to medium sized batch production and for machining of more demanding contours where it is easier to specify control information digitally. Numeric controlled (NC) and computer numeric controlled (CNC) machines are based on the same principles, but CNC is a refinement and further development of NC machines. These machines control tool speeds, feeds and movements via digital information stored in some memory (tapes, discs or electronic circuits). The term NC machine is used to indicate that there is a differentiation between the stage of planning and writing a numerically controlled programme and the stage of the actual machine operation. The term CNC machine is used to indicate that the computer is integrated into the machine. Increased miniaturization, memory size, computing capacity, speed and ease of programming for the user and the possibility of integration into wider information networks characterize CNC machines. Visual display units and increased operator control of the process also characterize these machines. NC machines are older versions of computerized control of industrial processes (Sorge et al, 1985). NC machines have been available in South Africa for quite some time. The use of CNC machines is relatively new here.

4.1 THE MANAGEMENT'S VIEWS OF THE EFFECTS OF CNC MACHINES ON THE WORK DONE IN THE FACTORY

The following firm to be discussed has recently installed CNC machines. It also has a computerized management system connected to the factory floor. The engineer and the personnel manager of the firm were interviewed to obtain the opinion of management on the effects of technological change on the work done in the factory.

This firm is engaged in the manufacture of mining pumps as well as of rubber components used in these pumps. The cutting and drilling of metal is done using CNC machines. Rubber moulding is still done by conventional methods. The company offers a technical service to customers by giving recommendations on pump selection and the use of pumps in a plant. It also undertakes maintenance services of these pumps. The firm is a subsidiary of an international company. It makes use of both batch and repetitive production processes.

There is a separate department in the firm for each of the following work activities: research and development, design, manufacturing and assembly, storage and handling of materials, distribution of products, installation, maintenance of machines, data processing, training and management and administration. Each department spends most of its time on the allocated work functions. The staffing in this firm favours management, administrative and clerical personnel rather than production workers. The management and administration section consist of one engineering, 37 executive and managerial, 19 administrative, 40 clerical and secretarial and 8 data processing members of staff. The manufacturing, sales and maintenance section consist of: 27 technicians and technologists, 16 sales personnel, 21 foremen and supervisors, 22 skilled artisans, 11 maintenance staff, 15 operators, 5 inspectors, 22 unskilled workers and 10 cleaners.

In addition to the CNC machines which are used for metal cutting and drilling, the firm has a computerized management and planning

system, which was regarded by the respondents as the driving system behind the organization of the firm. Information on all aspects of work processes is readily available. Use is made of micro-electronics to plan the flow of work, to record labour used, to plan materials requirements and to monitor work in progress. It is also used for cost, quantity and time estimates, inventory management, control of works orders and monitoring work in progress. Programming of the CNC machines is done in a separate location, at what is called a computer aided manufacturing (CAM) station.

The most important expectations of both CNC and computerized management technology, influencing the decision to introduce it, were increased record accuracy, improved efficiency and productivity, increased output and competiveness. Before the new equipment was installed the manufacturer and the major supplier of the machines were contacted. The technical and managerial staff of the company were also consulted.

In the opinion of the engineer, after the introduction of micro-electronics, value engineering became an increasingly important aspect of the work. It was necessary to eliminate certain operations on the shopfloor and to replace or change certain others. The quality of the raw material became more important as faulty material could cause problems in the cutting programme. Specifications and sizes had to be planned even more accurately than previously. The firm had to ensure that the foundries supplied materials to the exact dimensions specified.

No new markets or customers were found so that trade could expand after the introduction of CNC machines. This is due to the specialized nature of the product.

The new equipment was installed to replace existing equipment. Although cost estimates were made before installation, there were many hidden costs, namely additional servicing, training and new tooling costs. The equipment was installed by the engineer and the

vendor. A training package was included, but experience in the long term was more important in understanding the equipment than this training package. Initial problems experienced were due to ignorance of the accuracy levels required in programming and operating the machine. A special programmer is employed to draw up new programmes and to change existing programmes for new processes.

The equipment is maintained by the supplier or else by other outside companies specializing in mechanics and electronics. The shortage of specialized technicians in South Africa to maintain CNC machines has meant that at times machines stand idle, thus affecting the company's profits. However the supplier offers technical support and contact with the manufacturer when necessary.

Posts created since the introduction of microtechnology into the firm include the following: One CNC programmer (mentioned previously), one CNC supervisor and 14 CNC operators. The best people who were already employed by the firm were trained to fill the new posts. The CNC operators were drawn from the shopfloor workers irrespective of formal qualifications. Thus either a manual labourer or an artisan could be appointed as a CNC operator. Some of the operators do their own tooling and some do not, depending on their qualifications and experience. Since the installation of the CNC machines, staff employed to work directly with cutting processes has dropped by approximately one third. Nobody was fired, but people who left were not replaced. There are no vacancies in the firm at present. The contribution that this firm will make to creating new jobs in the future is therefore a negative one as more jobs were lost than were created by the introduction of the new technology.

With regard to new skills needed and those made obsolete by microelectronics, the engineer interviewed felt that the skilled artisan, more than any other group, had lost traditional skills. Semi-skilled or skilled artisans could be used as operators if they had the ability to learn to understand the principles of CNC pro-

gramming and operation. All groups directly involved in production, namely technicians, foremen and supervisors, skilled artisans, semiskilled workers, maintenance staff and inspectors, had to learn about computer numeric control. In addition, the management had to learn to operate the MRP system.

The workers received additional training from the company by in-service and on-the-job training, from the vendor and, for a few, from a technikon. The training can take from one week to a year, depending on the level of functioning required of the trainee. There is a shortage of skills in CNC programming and operating. But the biggest lack of skills is in maintenance. Tool setting and guaging require more skill than they did previously.

Regarding industrial relations, the workers were informed of the changes via works committee meetings and by means of correspondence. The replacement of old equipment and how this would change jobs was discussed by management and the works council. There was no trade union involvement.

Since the introduction of CNC machines, the engineer felt that the work had become less tiresome for the workers. But the machines have to be properly set up and checked, or else a lot of scrap is generated. Working with the new machines may be more monotonous than doing the work using traditional methods, in the opinion of the engineer.

The advantages of the new technology when it is functioning well, are that it makes a good product and it has a high volume of output. There is less reliance on skilled staff to operate the machines, and generally less staff is needed. The firm has a good advantage over competitors in that it can make a consistently high quality product.

The disadvantages concern the lack of maintenance skills. If a machine breaks down, it is difficult to fix because understanding of

the technology is incomplete. The machines are not made locally. Parts can be difficult to obtain. There is a lack of sufficient back-up staff and the machines are very expensive to maintain. The large capital outlay means that large batch quantities are needed to gain any economic advantages from using the machines. Lack of versatility of the machines was also mentioned by this respondent who felt that changing programmes is a time consuming task.

In future the firm intends installing industrial robots, computer-aided design and additional computer-based sensing equipment. This will help them to automate welding, loading, turning, drilling and design operations. South Africa is beginning to manufacture its own high technology equipment and machinery. If this process is continued, there should not be problems in obtaining new technology in future. However the amount of specialized skills needed for high technology and the dearth of these skills in South Africa at the moment is the biggest problem facing South African industries in the future, in the opinion of the engineer.

4.2 THE WORKERS' VIEWS OF THE INFLUENCE OF TECHNOLOGICAL CHANGE ON THE WORK DONE IN THE FACTORY

In addition to the management staff interviewed, four of the operators of the CNC machines were interviewed.

The first employee to be interviewed was a skilled fitter and turner. He was engaged in tasks involving roughing out and finishing off the shafts of the pumps. He made use of both the earlier NC machines as well as conventional tools. In order to use the NC machine, the respondent felt that is was important to have a basic artisan training as a fitter and turner as well as a computer background. The artisan training is necessary in order to understand the drawings used by the machine and how to modify them according to the required size. In order to operate the NC machine, however, a knowledge of the principles of how the machine works and training in how to set it up, is required.

The initial training that this respondent received to work the NC machine lasted approximately one month. The machine was already installed when he joined the firm and his supervisor and the other artisans trained him to use it.

The advantages of the new technology, in the opinion of this respondent, were the following: physically the work was less strenuous; it is completed much more rapidly; the machine takes 18 minutes to complete a shaft, while it takes two hours to do so using a conventional lathe; the product is consistently better; the finish is better and the covers in front of the machine make it safer than a conventional lathe.

There are however some disadvantages. The worker is under more mental pressure because he has to be more vigilent. The work is more boring. In the beginning, it was more interesting but once you have mastered the basics, it becomes monotonous. The machine takes jobs away from people because one of them can do the job of at least two people. There is no career development. Once you have mastered the basics, the job does not alter. Everything occurs at a fixed rate determined by the machine and no deviations are allowed but the worker has to be constantly alert in case something goes wrong. If the machine breaks down, the work comes to a standstill and an outside specialist has to come in to repair it. The machine takes away skills by doing the work for you. The programming is done at a different location from where the NC machine is situated thus there is no opportunity to learn programming skills.

Overall this respondent felt that a better product is made but the worker suffers both as a result of job losses and of deskilling.

The second respondent had a more positive approach to the new technology than the first. He was a skilled fitter and turner, setting the tooling for and operating a CNC milling machine. In order to carry out his present job, he had to learn how to work the controls and settings. His artisan training is directly applicable to his

present work, because he has to use his knowledge to be able to set up the machine. In order to use the CNC equipment, he received one week of in-service training by the overseas company that installed the equipment as well as from the programmer. As far as setting up and operating the machine is concerned, he feels that it requires at least a year's experience before he will become fully proficient. On the other hand, his experience as an apprentice was all he needed to help him to do routine maintenance of the machine. It is easy to carry out these maintenance tasks.

The production manager informed him of the change before the new machines were installed. The trade union to which he belongs was not consulted and no negotiations took place, as far as he is aware. He was pleased when the new equipment was installed, because he could have the opportunity to learn new skills. He still enjoys using the new equipment, except when it gives problems. It is important for him to learn how to operate the CNC machines, because in future it will be very easy to get work once he has mastered the technique. More and more firms will start to use the new technology thus creating jobs for the CNC operator. To him, work became more interesting because he had new things to learn. The worker's responsibility is increased, because there are more things to check, more calculations to do, particularly regarding setting up and offsetting. This places the worker under more stress than when using traditional methods. The work is more dangerous, because if the machines are not properly set up, an accident can easily occur. More precision is needed. Once the machine is working properly however, the work proceeds at a faster rate. More products are made which are of a better quality than those made by older methods. CNC allows for more accurate milling than conventional methods. The finishes are also better.

The new technology creates jobs, in the opinion of this respondent, because you need people to install and programme the machines. Career development however, is not possible because, once you have mastered the basics, your job is relatively fixed, and you cannot

get further promotions. It does however encourage creativity, because you have to be alert and constantly thinking about the processes in progress. It is easier to introduce new goods because, once the machine is programmed, you can make a varicty of products.

To this respondent both a better product as well as more interesting work was offered by the new technology.

The following respondent also felt that his job had improved since the introduction of the new technology but he could see that other people may not necessarily benefit from the change. He is a trained setter engaged in setting up the tools for the CNC machines. He is also busy with efficiency timing aspects of work done by the machines. In addition to his technical training he must have a knowledge of mathematics and he has to be computer literate in order to carry out his job. He also needs to know how to programme in order to be able to use the computers on the machines.

He spent three months learning to set up the first CNC machine. This training was given to him by the CNC programmer. It now takes two to three weeks to learn to set up each additional new machine.

The personal advantages to this respondent were numerous. More and more machines are being introduced and he gains a wider knowledge base each time he masters the setting up of tools for a new machine. The job has become more challenging and he has more responsibility because he is handling expensive equipment. The machines are less dangerous than conventional ones because there are guards and sliding doors to protect the worker. New job opportunities are created for him each time he learns to set up a new machine. Physicallly the work is easier because the machine itself does the work, once it is set up. He finds his job more creative because he is engaged in problem solving tasks.

This respondent is in agreement with the others concerning the better product that is made by the machines at a much faster rate than

previously. He also agrees that programming, servicing and repair of the machines require specialized training. This can cause delays if there are not enough skilled people to do these tasks.

The disadvantages mentioned for him personally were the following: he now has to work shifts; there is more pressure on him to be vigilant because of the huge expense involved if things go wrong; work load is increased because he is responsile for more machines and hence more production than previously.

The disadvantage for others is that it takes jobs away from people. The work is done much faster so that less than half the number of people are needed to produce the same quantity as previously.

Overall this respondent felt that new technology presents a challenge and creates jobs for the ambitious person who is willing to learn to become computer literate. But it takes away jobs from others.

The final respondent in this firm was a semiskilled worker engaged as a CNC machine operator. He was previously working on a turret lathe, manufacturing shafts. He is now making exactly the same product using a CNC machine. He feels that his work is completely different from what it was previously. In order to carry out his work, he had to learn how to read the instruments and drawings and he also had to learn how to set up the machine. A great deal of care is needed with the setting up programme. The right tool will not go into the working position if you make even a slight mistake. In addition, basic knowledge of fitting and turning is also required. The programmer of the company taught him how to operate the CNC machine. Training took one month but he needed further experience before he felt that he could operate the machine properly.

The advantages and disadvantages mentioned by this respondent are the same as those already mentioned. His opinions are summed up by his closing words: "People are losing jobs through these machines.

Production is good for the company. It is good for the people working on the machines. But other people are sitting without jobs because of the machines."

The fears that jobs will be lost among those who do not acquire the new skills are realistic when the amount of unemployment in highly industrialized countries is considered. However there are many factors affecting unemployment besides the new technology. It seems as if there is a dire need for better communication of change and its effects as far as management is concerned. People need to be made aware that technology can destroy work skills and reduce employment in some fields but that on the other hand, it creates jobs and new work skills in other areas. Education and training in those areas where jobs will be available in future should be given urgent priority if the Luddite backlash is to be avoided.

CHAPTER 5

CHANGES BROUGHT ABOUT BY THE USE OF NEW TECHNOLOGY IN A LARGE FIRM

The next firm to be discussed manufactures rolling stock, for example wagons, for use on the railways. The firm is part of the private sector. It is a large branch of a larger firm employing over 1 000 people at the factory site. The type of production is primarily repetitive and there is little demand for new designs or products.

5.1 MANAGEMENT'S POINT OF VIEW OF THE INFLUENCE OF TECHNOLOGICAL CHANGE ON THE WORK DONE IN THE FACTORY

The managing director of the branch supplied the information and gave his opinions on the new technology, from the point of view of management.

He divided the time that is spent on the various work activities in the factory as follows:

35% of time per month is spent on manufacturing of products;

50% on assembly;

7% on handling of materials;

1% on each of storage, maintenance, data processing and training; and

4% on management and administration.

Employment is given to people in a number of categories. On the administrative and management side there are two engineers, while

seven people are employed in executive or managerial posts and 17 people are employed in administrative, secretarial, clerical and data processing jobs. In the actual factory, there are three technicians, 50 foremen and supervisors, 92 skilled artisans, 25 apprentices and 72 maintenance staff. In addition, there are 335 semiskilled and 408 unskilled workers.

This firm has installed the following computer based machinery and equipment: four industrial robots which are used for welding operations and four CNC profiling machines, used for metal cutting. In addition they make use of computer assisted design to generate types for the CNC machines. This is however done at head office. The power supply and the temperature control of the furnaces are also controlled by microchip technology. A computer based scheduling system has been introduced and at the time of the interview, the company was in the process of installing a computer based management system for inventory control (MRP). In addition they have some personal computers and terminals linked to the head office. This firm is therefore in the initial stages of linking the various technologies together to form a system.

The head office, in consultation with branch management, decides on what new machinery and equipment to install. Before computer based technology was installed, visits were paid by head office staff to vendors of the new equipment overseas. They also visited overseas companies manufacturing rolling stock.

The company for whom the rolling stock is made influenced the decision to introduce the new technology. They had already introduced industrial robots into their own workshops and they wanted the firm under discussion to manufacture new products of the same standard that they were making in their own workshops by using robots.

Before the new technology was introduced, management of the branch, technical staff and an outside engineering firm were consulted. The members of staff who would be using the new technology were

also consulted. The expectations held regarding the benefits of the new technology were similar to those already discussed, namely shorter manufacturing times; improved quality, efficiency and productivity; increased output, reduced costs for labour and materials and increased competitiveness.

In common with some of the previous firms, the new technology was not installed to manufacture any new products. Its flexible functions are hardly used. It is used to make the same products more efficiently. No new markets were found for the improved product, as the only other possible buyers are the railway companies of other countries.

The installation of computer based equipment did not really present any problems. This equipment both replaced and supplemented older equipment. The vendor installed the robots, and the company, with the help of the vendor, installed the CNC machines. There were unforeseen costs concerning the initial accuracy and reliability of operation. This applied particularly to the CNC machines because the computer's capacity was too small to cope with the task it was required to do. The most difficult task as far as the robots were concerned was that of selection. It was difficult to know beforehand the level of sophistication that would be required of the robot and how many movements it would be required to perform.

Programming does not really present any insoluble problems. The programmes of the CNC machines are not difficult to change but they require new tooling. For major changes, the company would make use of an outside consultant.

There are problems with major maintenance of the new technology. Reliance on outside companies is not always possible because they are not always familiar with the requirements of the firm, and people who receive training from the vendors or through the company possess highly marketable maintenance skills and can easily find another job. The support received from the vending companies var-

ies considerably. The firm selling robots offers a better service than the firm selling CNC machines.

The effects of the new technology on post structure are similar in this firm to the previous examples, and indicate possible future trends affecting companies where new technology is introduced into an industry where there is no planned expansion of markets.

One new post was created, that of CNC profile machine programmer. In addition three people previously employed as semiskilled workers are now employed as robot operators. Twelve welders have been redeployed and their skills are now used in other branches of the firm. Certain other welding jobs have been made redundant. The respondent felt that robots, rather than the CNC machines, replace people. Whereas robots do the job more efficiently than people, and require less supervision, CNC machines require more supervision than robots.

Although fewer people are now required to perform the jobs than previously, no people were actually fired as a result of the introduction of robots. People are used elsewhere in the firm. Staff numbers have been reduced through natural attrition, rather than through dismissal. People who leave are not replaced.

According to the respondent, the question of job loss in their firm is a complicated one. The limited market for which their products are made means that the company cannot create more posts by selling more products. Rather than expanding their market, they aimed for greater productivity and greater efficiency in manufacturing what is essentially a fixed output when they installed the new technology. They wanted to improve their systems and reduce costs by using new technology. Labour costs and the cost of materials are reduced in this capital intensification of production. This is one of the benefits, from the point of view of management.

On the skills questions, the respondent indicated that, in addition to basic skills, various employees, from professional engineers to skilled artisans, need to have an understanding of electronics, a knowledge of programming and an appreciation of just-in-time manufacturing concepts. This will become increasingly necessary as the firm moves away from the batch manufacturing systems towards better use of available materials and less need for storage. This involves, in many ways, a reversal of what was previously taught. It was previously necessary to have large quantities of materials stored to ensure that production was not delayed through lack of raw materials. But now, through computer aided management, and direct links with the factory floor, it is possible to minimize stores and use materials more economically. To do this means learning new skills.

The point was again made that the semiskilled and unskilled workers have to pay more attention to detail. They have to be more accurate in setting up the material. Therefore they require more powers of concentration than was previously expected and their jobs have also changed.

A new aspect was raised regarding skills. In the opinion of this respondent, computerization introduces a trend away from specialized skills towards the need for multiskilled people. There is a need for a person who can operate and programme several machines simultaneously, rather than one who can only perform welding tasks, for example.

Regarding any shortage of skills in South Africa at present, the respondent felt that there is a lack of competence in many areas rather than a lack of qualified people. Obtaining a qualification as a skilled artisan does not necessarily lead to competence as an artisan. The factory needs competent artisans, supervisors and maintenance staff and such competence is lacking. Although all the posts in the branch are filled at present, the people employed are not necessarily competent in the skills they purport to possess.

The main problem remains the large numbers of unskilled people who will find it increasingly difficult to get jobs in future. In many cases, the new technology has meant that jobs are being created for semiskilled rather than skilled workers.

The operation of the new machines actually requires less skills than those that were required to carry out the tasks manually. Thus fewer skilled workers can do the job of operating the robot when compared to the number of skilled workers required to do welding. More care is needed by these less skilled workers than was demanded of them previously. Skilled people are required as a backup to supervise and maintain the new equipment and to introduce new programmes.

A number of effects on management were also mentioned by this respondent. The introduction of new technology into this firm has led to feelings of pressure on management to become more familiar with computerization. The present respondent indicated that there are large areas of knowledge that have to be acquired as a direct result of the introduction of the new technology. Managers need training in electronics, in just-in-time management concepts and in new computerized systems of quality control. They need constantly to keep up to date with new developments in computer technology applicable to their industry if they want to run the firm efficiently.

As far as other personnel are concerned, one week's training was again needed to learn to programme and operate the industrial robot, and approximately three weeks' training was needed to use the CNC machines. Both the company and the vendor were involved in training. For people using the new equipment, experience is just as vital as training in making it work efficiently. The semi- and unskilled labour work on 24 hours notice, therefore the company is less vulnerable if workers are more flexible and are taught more than one skill. Training in the factory is ongoing for this reason.

Before the introduction of the changes, the industrial relations issue was handled by asking the supervisors to inform the workers of the proposed changes. They were required to explain that the main concern was for improved productivity. The robot would be used for those processes that were difficult to do manually. The workers were not directly consulted, but an attempt was made to reassure them that no individual would lose his job. There have not been any repercussions from the workers or from the trade union since the new technology was introduced. The respondent felt that the workers were happy with the change, because they do not have to do a physically strenuous, monotonous and tedious job any more as the robot now does this job. The staff who operate the robot show an interest in keeping it running smoothly and seem to be satisfied with their work. On the other hand there may be fears among the staff of job loss, but this has not been discussed.

Generally, the new technology had many advantages for this firm. A better product was made more efficiently than previously.

The disadvantages highlighted have all been previously discussed but deserve restatement in view of their general importance to all firms. For a robot and for a CNC machine to function efficiently, the preparation has to be carefully done and it must be consistent and accurate. Large quantities of scrap can be generated if care is not taken. The large capital outlay needed is also a disadvantage, although the equipment eventually pays for itself.

There are many plans in the pipeline for further computerization at the branch. A just-in-time management system will be introduced, and the materials resource planning system will be extended. A new computer aided design and computer aided manufacturing system(CAD/CAM) linkage is being considered, and the introduction of more microcomputers for individuals is being planned.

The biggest problem in introducing the new technology in general, according to this respondent, is the lack of education of the un-

skilled labour force. This often means that the technology is not used properly. He does not see the threat of sanctions as an insurmountable problem, but rather that the lack of education of the work force is the biggest threat to the succcesful use of high technology. An uneducated population cannot use sophisticated equipment properly.

5.2 THE EMPLOYEES' PERSPECTIVE ON HOW NEW TECHNOLOGY HAS INFLUENCED THE WORK DONE IN THE FACTORY

In addition to the managing director of the branch, three workers at the firm were also interviewed.

A worker operating one of the robots indicated that he was a semi-skilled worker who had acquired some welding skills. He had then learned to operate the robot. He received on the job training from the engineer of the firm. It took about three months to become fully competent. The robot makes his work easier. It can do more jobs than a person is capable of doing. Unlike a previous robot operator, this one regarded the work as being less dangerous than previously, because you can distance yourself from the potentially dangerous process of welding. This respondent finds it interesting to operate the robot because he has learned new skills. There is less competition for jobs as robot operators as there are not many people who can do the job. The robot does however increase workload, because the worker is required to do more work in a given time and to keep up with the machine.

Both of the two other workers interviewed were semiskilled lock welders who were using conventional equipment to do their work. They both indicated that they were not told of the change. They just came to work and found robots. The first of these respondents felt that robots make his job more pleasant because they have taken away some of the more difficult tasks. He nevertheless felt that he is capable of doing work that is better, more responsible and more challenging than the work done by the robot operator, because this

operator just has to press buttons, and he has to actually perform welding tasks. The manual worker has more control over the work he is doing than the robot operator has. But operating a robot requires more vigilance than conventional welding. The work of a conventional welder can become very routine. He fears that robots will take jobs away from people, because they do the work that people used to do. People are more flexible than robots, because they do not have to be reprogrammed to do a different job, although they may be less consistent. People, rather than robots, need jobs.

The second lock welder praised the quality, the quantity and the consistently high standards of the work done by the robot. He also stressed the greater versatility of humans in performing many tasks compared to the limited number of tasks the robot could do. He expressed a dislike of robots, because they were taking away all the jobs from people.

Both the above respondents denied that they were informed in advance of the installation of the robots. They found them at the workplace and just wondered what was happening. This differs from what management intended and a breakdown of communication seems to have occurred between management, supervisors and the workers. Better communicaton is essential to avoid a possible "Luddite" reaction by workers, and greater endeavours should be made to discuss the new technology and its effects with the workers. The fears of the workers are realistic if viewed form their perspective that their specific job would be lost. This applies particularly in this factory where no expansion is planned.

CHAPTER 6

THE EFFECTS OF USING A FLEXIBLE MANUFACTURING SYSTEM

Two members of the management staff were interviewed in the following firm. The first was the personnel manager, and the second, the engineer in charge of production. The company is a subsidiary of a large international company. It functions independently and is managed locally. Most of the research and development of this firm is however done overseas, and only a small range of their products is manufactured or assembled locally, namely auto-electrical components such as alternators, starters, ignition coils, wiper motors and fan motors.

This firm has gone a considerable way towards computer integrated manufacture. The factory floor and stores are linked to the administration section by means of a materials resource planning (MRP) system. Information on sales, stock and workers' records are then transmitted to management by computer terminals which are found throughout the firm and which are linked to each other in a network. The system works by asking each worker to key into the terminal what work he has completed, and what materials he has used. The worker has access to only that information regarding his own particular work station. Management has full access to all information at all work stations. The decision to install this system was taken locally. This system does give some problems as it relies on the integrity of the workers, who can easily punch in fictitious quantities to make their figures look good. A lack of co-operation between the various departments has also caused problems in the past.

In addition to this MRP system, there are many other types of computer based equipment which have been installed in this organization. The parent company actually manufactures flexible manufacturing systems (FMS) and an automated flexible conveyer belt system used for assembly has been installed by the parent company.

It plans to market this equipment in South Africa, and has installed it in the local factory to try it out and adapt it to local needs. The decision to install this system was taken overseas without involving the local management in the decision making process. This flexible manufacturing system (FMS) differs from conventional conveyor belts. The conventional system is rigid in that the previous task has to be completed before the product being assembled can pass on to the next stage of assembly. The assembly takes place at the pace of the slowest worker on the assembly line. The new system contains sensors which monitor the rate at which the tasks are being done. Parts being assembled at a slower rate can be deflected to another circuit so that the manufacturing process is not delayed. At each work point of the flexible conveyer belt, a machine can be installed to do the specific task, or else a human operator can be used. It is therefore possible to replace all the workers on this system with automation, but the factory under discussion has not done so. It has installed machines along the system to do tasks requiring a high degree of accuracy and consistency. These machines and the humans work together side by side. The work done by the humans is relatively simple. For example the person is required to pull a lever or to rotate the product. Machines could easily be installed to do these tasks.

This factory is now producing the same goods as previously, but it does so more rapidly. No new markets have been found because the motorcar industry, for whom the products are made, is being affected by the current recession.

Futher programmable technology includes some degree of automation of materials handling, where the movement of cranes is controlled by computer. A computer aided design (CAD) system has also been introduced. It is used by two designers. However there is not much scope for design in the local company, as most of the design is done for the local company by the parent company overseas. There are also three CNC machines used for turning and finishing. In addition the company has a programme which indicates when machines

were last maintained, when they need servicing and when a machine is continually breaking down and is becoming uneconomical.

The time spent by the enterprise on various activities is allocated as follows:

40% on manufacturing;

40% on assembly;

3% on each of handling, storage and data processing;

2% on each of training, repairs and servicing, research and development, and design; and

1% on each of management and administration, installation and maintenance, and distribution of products.

A total of 509 people are employed by this company. The classification system of the staff is based on that of the parent company. It does not give an indication of the level of skills. It does however indicate the area in which they work. 269 people were employed in direct and 36 in indirect labour. There were 21 people employed in production preparation, 27 in direct and 15 in indirect inspection and quality control. In addition 47 were employed in the toolroom and main service centres, 30 in materials planning, 9 in personnel, 18 in sales and 4 in research and development posts. In addition there were 16 administrative personnel.

The new machines replaced existing equipment. The economic gains expected versus the costs were calculated before the new machines were installed. There were many hidden costs however. One unpredictable factor was the sharp drop in the rand dollar exchange rate

that occurred at the time the equipment was purchased. Additional programmes also had to be bought to adapt the software to the way in which the technology would be used locally. The flexible manufacturing system (FMS) was installed by the company with the help of a consultant. A training package was included, but it was unsuitable for use in the South African context. When the FMS was installed, they found that there was insufficient computer capacity, that new programmes were needed and that there were problems associated with saving data and duplication. Initially there were programming problems, because it takes time to understand the system, and the necessary experience was lacking. A specialized programmer in the company programmes the FMS equipment and changes the programme when necessary. The FMS is internally maintained, repaired and serviced. Lack of experience presented initial maintenance problems.

The post structure changed as follows: 36 computer keyboarding jobs were created as well as 5 electronics technicians posts. Twenty posts for semiskilled production operators changed. These people were now required to work on the FMS assembly line. So far no one has been dismissed and vacant posts caused by resignations are being filled. In the end probably 10% less staff will be needed. There are 3 vacancies at present: 1 secretarial post and 2 posts for quality control inspectors.

The main knowledge required is an understanding of the principles of pneumatics, hydraulics and electronics. Analytical abilities are also necessary for the engineers, technicians, technologists, servicing and maintenance staff. The foremen and supervisors require an understanding of computer operating. Toolmakers had to learn programming skills. Semiskilled workers had to learn to operate the new machines. Their jobs have become simpler as less thinking is involved. The unskilled workers are not affected.

As far as job enrichment or deskilling are concerned, the jobs of the semiskilled assemblers were those that were most likely to be

negatively affected by the FMS. These workers now have less responsibility. The toolmaking and electronics technicians jobs have become more skilled since the introduction of the new technology. These workers now have to be computer literate in addition to previously acquired skills.

The company does its own training which covers a variety of areas, depending on the occupation of the encumbent. Engineers, technicians, technologists and sales staff are given a complete training on the working of the FMS system. The engineers are sent overseas to the parent company for further training in systems development. Maintenance personnel are trained to detect faults on computer systems. Foremen and supervisors are trained to use the MRP system. Management are also given training in computer skills. Clerical staff are taught word processing and data keying skills. The skilled artisans are taught programming skills to operate the CNC machines. The semiskilled workers are taught how to key in data for the MRP system. The unskilled workers are not affected. There are 11 instructors employed by the firm, and ongoing training is provided. Courses are offered at various levels for specific areas as and when necessary.

Regarding communication of change, information on the installment of the MRP and FMS technology was passed along to the workers through the normal managerial hierarchy. A meeting was held with the shop stewards who were then asked to inform the workers. Foremen and production managers also informed their workers of the change. The trade union approached the management when they found out about the installation of the FMS. Negotiations took place with the unions.

The respondents felt that the workers on the FMS line were happier with their jobs because the environment was much more pleasant than previously. However, there are fears of job losses among the employees. The company hopes to avoid retrenchments. They plan to introduce new technology gradually. The decision to proceed at a

relatively slow pace was influenced partly by the current political and economic climate in the country, and partly because of the huge capital investment involved.

The advantages of the new technology, from management's point of view, are the following: as far as automation of the factory floor is concerned, this has meant that the quality of the product has improved and efficiency and productivity have increased; the method of production is now more structured; pile-ups no longer occur on the assembly line of the FMS; the flexibility of the system allows operators to be replaced by machinery and machinery to be replaced by operators and the superior quality of the product has allowed the firm to maintain 60% of the market, in spite of the economic recession.

Regarding the automated management system, the following advantages were mentioned: the materials requirements planning system avoids pile-ups of raw material; there is less paper work; information on production or on aspects of management are instantly available and record keeping is more accurate.

A number of disadvantages were outlined. The initial capital outlay is very high. In view of the static nature of the market, it will take a long time before the system becomes cost effective. The initial training of the staff is a slow process and they require experience to become proficient. Jobs and job opportunities will eventually be lost in some areas, whilst in others specialized people will be required to keep the high technology functioning efficiently. Initially more people may be needed because the firm has not yet adapted its methods of organization to the requirements of the new technology but eventually there will be fewer people employed. The biggest problem is the lack of trained people in the computer field.

In future a constant but gradual flow of new technology will be introduced into this factory. All aspects of manufacturing and man-

agement will be affected, including planning, orders and sales. This firm does not foresee any problems in obtaining the new technology because the parent company manufactures high technology products. In general, management was very satisfied with the new technology.

6.1 THE OPINION OF THE INDUSTRIAL RELATIONS OFFICER OF THE IMPACT OF THE NEW TECHNOLOGY ON THE WORKER

The industrial relations officer of the firm was interviewed because the firm was afraid of industrial unrest should interviews be held with some of the workers. The issues to be raised in the inverview regarding the new technology were deemed very sensitive. Management feared that the workers may regard the interview as concrete evidence that job loss would occur.

The industrial relations officer stated that the workers were very suspicious as they feared that the introduction of FMS would force the company to retrench some people. However their fears have been allayed to some extent because no jobs were lost following the introduction of the first FMS.

He felt that the people working on the flexible manufacturing system are under more pressure than they were previously because the conveyer belt keeps bringing work to them at a constant pace. As soon as they finish one task, the next task is ready for them to do. They cannot move around as much as they could previously. Thus there is less interaction between workers. The job has become easier because the tasks requiring more precision are done by the machine. It has also become more boring because the same repetitive task is performed day in and day out. If one bears in mind that in a fully automated system, machines would be placed at the points where the workers now sit, it is understandable that the work is very tedious. The employee however has to concentrate more intensely than previously because the rate of work is controlled by the machine. He cannot leave his workplace unattended. The indus-

trial relations officer felt that the work was less dangerous than previously as the workers are required to sit in one place and press levers, or turn the product or perform a similar, very simple task. There are no opportunities for promotion because nothing extra can be done besides the simple repetitive task. The work load is increased because as products move along the conveyor belt, they require instant attention. Physically however the work is much easier than previously as the machine does the strenuous tasks. Productivity is improved because the rate of work is regulated by the machine. The person cannot delay production. Efficiency has improved because the work has become so simplified that it is very difficult to make mistakes. The work has therefore become deskilled.

Most of the difficult work, for example programming and maintenance, is done by specialists. Simple computer operating skills are however required for the MRP system.

The only consolation for the workers is that no jobs have been lost. At times of high unemployment many of the workers regard themselves as lucky to have work. On the other hand, no new jobs have been created.

The needs of management for efficiency and high productivity and the needs of the workers for secure work in an environment that allows for some expression of individuality, are diametrically opposed. This is one of the dilemmas posed by modernization. It is very difficult to make work interesting and relevant for the worker on a flexible assembly line. This problem is not new. Since the beginning of mechanization the breaking up of a task into simpler processes has been a feature of work. For the worker this has meant performing a repetitive task for hours on end. Much has been written on the alienation of the worker from the end product of the work he is doing. New technology, if used in such a way that workers and machines both do simple repetitive tasks alongside each other, increases the problems of alienation.

CHAPTER 7

THE EFFECTS OF THE USE OF BOTH ROBOTS AND NUMERIC CONTROL OF MACHINES IN A LARGE ORGANIZATION

The mechanical department of the following organization to be discussed is responsible for the maintenance of all rolling stock on railways and harbours and for the maintenance of harbour equipment. It also manufactures some of the spare parts it requires to maintain the rolling stock as well as some of the actual rolling stock used by the railways. A head office and various specialist departments control 11 workshops throughout the country. Interviews were conducted with an engineer in the head office as well as with four staff members at one of the workshops. The department in which the engineer worked was directly responsible for the running of the workshops. There are separate departments responsible for research and development, design (including computer aided design), storage, distribution of products and data processing. Members of these departments were not interviewed, as the main focus of this project is on the way in which new technology has influenced the work done in manufacturing, rather than in other areas.

7.1 MANAGEMENT'S VIEW OF THE EFFECTS OF NEW TECHNOLOGY ON THE WORK DONE IN THE FACTORY

The engineer of the department directly responsible for running the workshops indicated that the staff of the mechanical department at both the head office and its workshops spend the following percentage of their time on the work functions listed below: 20% of time at work is spent on fabrication of products; 14% on assembly; 10% on handling of materials; 30% on repairs and servicing; 10% on maintenance of existing machines, 10% on training and 6% on management and administration. The mechanical department employs 37 people in professional, executive, managerial and administrative

posts. There are three technicians and technologists, 130 foremen and supervisors, 360 skilled artisans, 230 semiskilled workers and 1 000 labourers.

Computerized equipment, namely NC and CNC machines as well as industrial robots, has been installed to help carry out the following work processes: machine loading and unloading, metal cutting, flame cutting, drilling, tooling, assembling and arc welding. In addition, management make use of a computerized information and cost simulation system. This system is not however directly linked to the shop floor. The technologies were introduced on an ad hoc basis. More technology was added as and when necessary but there was no overall planning of how and when computerization would take place. This is in keeping with the way in which most of the other firms interviewed have introduced the new technology.

Before this department installed it, information on the new technology was gained through studying the available literature and by studying local systems and systems used overseas. The main reasons for introducing the new technology were the lack of skilled staff and a desire for improved productivity, efficiency and quality of products. The robots in particular opened the way for more intricate work to be done at a higher standard. The organization is now able to manufacture items that were previously imported. The new technology replaced outdated equipment but it also increased the manufacturing capacity of the workshops.

The latest equipment to be installed was the robots. The influence on the post structure of the robots was discussed with this respondent, rather than the influence of other computer-based equipment, as this was the area in which he had gained the most experience of the effects of change. No new posts were created as a result of the introduction of robots and 14 trained welders working as technical superintendents were redeployed to monitor the functioning of the robots. The jobs done by these people have changed completely. Their technical knowledge of welding has become

less important but their understanding of computer programming and operation has become increasingly important. People involved in using the new technology need a knowledge of mechanics, electronics computer programming and operating. Operating the robot is relatively easy and one operator operates four robots simultaneously. At present there are 40 vacant posts for skilled artisans. The inability to obtain sufficient skilled artisans to meet the requirements of the shop floor was one of the most important reasons for introducing the new technology.

The engineer involved with the decision to install the robots received overseas training in programming, operation and maintenance from the company that manufactures the robots. The foremen artisans and other engineers received one week's training from the local vendor. Now the organization does its own internal training. They also do routine maintenance.

The respondent felt that the workers were very positive about the change. The new technology had improved the image and status of the artisan. He, personally, was unaware of any negative reactions to the introduction of new technology by the workers. However if robots had not been installed, more jobs would have been created for skilled artisans. In view of the shortage of artisans, this loss of jobs does not really pose a serious problem. The unskilled worker is not being replaced by the new technology. The organization now makes products that were previously imported. No members of staff have therefore been replaced.

Due to lack of funds and the decreasing use being made of railway and shipping transport generally, there are no plans at the moment to introduce any further new technology into the workshops.

7.2 THE ARTISANS' IMPRESSIONS OF THE INFLUENCE OF TECHNOLOGICAL CHANGE ON THE WORK DONE IN THE FACTORY

In addition to the engineer, four artisans on the shop floor were interviewed. Two of these respondents were using conventional equipment and two were working with computer-based machinery. Their experiences make interesting comparisons regarding how work has changed.

The first respondent was a welder using conventional equipment to do, what he describes as, routine production work. He compared the work that he is doing to the work done by a robot supervisor in the organization. He is still doing the same job that he was doing before the robots were installed. He has had no training in the use of computer based equipment. His artisan skills are all he needs to do his present job. For the type of routine work he is doing, he does not even require his theoretical background in welding.

He heard of the introduction of the new technology via the grapevine. At first he was worried that jobs would be lost but now he does not really worry about it. In his own words he said: "It doesn't really bother me. I've got a job; I don't intend losing my job. If people lose their jobs, it's their own fault. They are not doing their job properly."

At the moment the new technology offers no advantages for him but if he gets the opportunity to learn how to use it, as he hopes he will, then it will give him an opportunity to learn something new and to use his intelligence ("brains"), which he is not doing at the moment. He is looking forward to the challenge of learning something new.

In the opinion of this respondent, robot technology makes the work more interesting. It increases the responsibility of the workers because it requires looking after. It has to be properly programmed. New technology makes more jobs available in technical

fields but it takes away jobs from artisans. It is less dangerous than conventional equipment because the work is mainly supervisory. The new technology creates opportunities for promotion, in the opinion of this respondent, because you are trained in a new field and you automatically enter a higher salary category. Working with the new technology increases stress placed on the worker because there is no stress placed on the worker who is doing routine welding work. Supervising the robot , on the other hand, "is like having men working under you". The work becomes mentally, rather than physically, demanding. The work load is increased because the robot supervisors look after more than one robot at a time. The robot is more productive than an individual because does not get tired and it does not make mistakes if it is properly set up. It does a job it has been programmed to do in a shorter time than people can do the same job and in the cheapest possible way. The finished product is of a more consistent quality when made by robots than when made by humans. However, the machine destroys the creativity of humans because there are certain set ways to run the robot and no deviation can be allowed. New technology will make people lazy. Nevertheless, there are still certain jobs that only humans can do that involve intricate welding. These jobs will still have to be done manually in the forseeable future.

Overall the respondent feels that the robot has made his own job more pleasant because the robot now does the more physically taxing tasks. He feels that robots should be accepted by the work force. The use of the robot will increase in factories and the workers cannot place obstacles in the path of progress. In the long run their work will be made easier.

The following respondent to be interviewed was a turner and machinist. He too was using conventional equipment to carry out his job. He is engaged in shaping material; in cutting grooves for nuts and bolts and in cutting gears and he uses a variety of cutters to perform these tasks. All the work that he is doing can be done through programmable machines. His artisan's training as a trainer and ma-

chinist is essential in order for him to carry out his work. He has not, as yet, acquired any skills which would enable him to use the computer based machinery. He too would like the opportunity to be able to learn to use the CNC machines because it would make his work more interesting.

New technology has no influence on the amount of responsibility one assumes at work in the opinion of this respondent because everyone has to accept responsibility for the work one does irrespective of the machinery one uses. As far as danger involved in using the new machines is concerned, these machines are dangerous if one has not received proper training in their use. However, if properly used, they are less dangerous than conventional equipment because the machine, rather than the person, does the work. New technology has no influence on promotion, in the opinion of this respondent, because promotion depends on your capabilities and not on the efficiency of the new technology.

The new technology decreases mental and physical stress on the worker and also decreases the work load because it does the work for you. It is easy to operate; you just press buttons.

The respondent thinks that it is difficult to learn to programme, operate and maintain the new equipment, particularly the CNC machines. But this may be due to his lack of experience. It looks as though the programme is easily changed for the machines to do different work. In general there is more challenge and new skills are being introduced in the workplace as a result of the introduction of the new technology. The respondent is satisfied with the changes.

The following respondent works as a toolsetter of the NC and CNC machines. He sets the machines up and prepares them for operation. In addition to his basic training as a turner and machinist, he had to learn the basics of toolsetting of NC and CNC machines. It takes a long time to understand the new machines and you need to be

able to think clearly in order to do so. Calculations of cutting speeds have to be done and the uses to which the various cutting tips can be put, need to be learned. This knowledge was acquired through in-service training. He received instruction from the previous person who was working with these machines. It took him six months to acquire this knowledge. As far as maintenance is concerned, he is able to correct the small faults but outside specialists are needed for major services and repairs.

Learning to use the new technology was seen as a challenge by this respondent. He still finds it a challenge as he feels he is using his abilities. There are new things to learn every day. The work is more responsible as you have to set higher standards. It is less dangerous as the machine is loaded only once and then it carries on with the tasks according to the programme. There are opportunities for promotion because you can advance to a job as programmer as well as to other technical jobs.

There is less pressure on him as a worker because áll he is required to do, is to set up the machines and then the operator has to watch that nothing goes wrong. In fact, sometimes there is too little work for him to do.

This respondent also felt that the machines are more efficient, more productive and more accurate than conventional methods. If the machines are properly programmed and set up, very little can go wrong except for the occasional electrical fault. The operator just presses the button and watches to see that there is enough water being sprayed onto the tools and that everything is operating smoothly. It is easy to programme the machine if you know the codes. It is easy to change the work done by the CNC machine although it takes a bit of time to reprogramme the computer.

Better prospects are being created by the new technology. In future, any job opportunities in industry will be based on the new technology and it will become essential to understand how the new

machines work in order to get work. However, some people will lose their jobs.

The final respondent at this organization has had experience on a variety of machine tools and computer based equipment. At first he worked as an artisan welder. He was then trained as a robot programmer and operator. He has also worked as a jigmaker making the necessary fixtures for the robots. He is at present working as a technical supervisor of the NC and CNC machines. His job is to allocate tasks to the people working with the various NC and CNC cutting machines and to see that they get the work done. The designs for the machines are obtained from head office. These are drawn up using computer aided design (CAD) technology.

In order to carry out his present job he needs basic artisan skills. He also needs to understand the working of the new technology. He needs to know how a computer functions and how to supply the computer with the information it needs to carry out the required tasks. In addition, he requires supervisory, planning and organizational skills to see that the work flows smoothly.

In order to operate the robot, he received a seven day programming course from the vendor. He received in-service training in order to use the other machines. He welcomed the introduction of the new technology as it took away a lot of the "donkey work". He has gained many new skills since the introduction of computer based technology and his work has become more interesting. His responsibilities have increased because he is accountable for breakages and stoppages of the machines. The work is also mentally more stressful because of the increased responsibilities. The quality of the work done by the machine is very high. "The machines are like people. Each has its own personality and you have to learn to get to know each one." But once you have the know-how they are easy to operate. Altogether the new technology has meant an improvement in the quality of life of this respondent. In his own words:"I go home not

as physically tired as before, but mentally challenged and I feel satisfied with the day's work."

In general these artisans were very positive about the new technology. They all felt that it was important to learn to use it for the sake of future job prospects. In this organization, promotion opportunities and variety do exist because the workers can learn to operate a variety of machines. New challenge is added by such rotation of jobs, enriching the work. The boredom experienced by some of the previous respondents is thus avoided.

CHAPTER 8

CONVENTIONAL AND COMPUTERIZED ASSEMBLY IN THE MOTORCAR INDUSTRY

A firm in the motorcar industry, manufacturing cars, trucks and tractors, was the next to be contacted. Only limited information is available from this firm because figures on the number of employees were not given. The management also refused to allow the workers to participate therefore no information is available on their attitudes to the new technology and how their work has changed since its introduction. Nevertheless, information gained from this firm is useful to include in the study because the motorcar industry has traditionally been a large employer of unskilled and semiskilled labour. Automation in this industry may affect the employment of large numbers of workers. The training manager of the firm was interviewed.

The main task of the firm is assembly and 70% of the time of the employees of the firm is spent on this task. A further 15% of time is spent on fabrication. The rest of the time is divided approximately equally between management and administration, data processing, training and materials handling. Very little design or research and development is done locally, because the overseas parent organizations perform most of these functions.

The little design that is being done locally, is performed using both computer aided design and conventional methods. Cutting and forming is done using both conventional equipment and CNC machines. These are also used for the assembly of the engines of the motor vehicles. The assembly of the body of the cars and other vehicles is done in two ways. A conventional assembly line is used to assemble most ranges of products. A new model is being made in a totally automated workshop. The body shaping and welding is done exclusively by industrial robots. In fact the robots were introduced for

the purpose of assembling the new model. The robots have a built-in quality inspection capability which ensures that the welds are accurately done in the correct places. In addition, the firm has a computerized planning and management system connected to the factory floor. All aspects of manpower management, finance and materials supply are computerized. Planning the flow of work, scheduling, monitoring the work in progress, inventory management and cost and time estimates are also computerized.

The decision to introduce the new technology was taken by the local board of directors with overseas consultation. Production engineers and technicians were sent to sister companies overseas to investigate which systems were being used by them. The decision to introduce robots was taken in order to keep the standard of production in line with that of Europe and other countries where robots and other computer-based equipment have been introduced extensively in the motorcar manufacturing industries.

The firm hoped that by introducing robots and other computer based technology, they would reduce manufacturing times and improve the quality of their products, as well as the efficiency and productivity of the organization. They wanted to save on materials and to be more competitive. They also wanted to increase the accuracy of their records and their management and administration.

In the opinion of the respondent, the impact on the market of the new way of manufacturing the new model, is difficult to assess.

The installation of the robots presented certain problems. This was due in part to the lack of experience of the local vendor of such large scale operations. There were two types of problems. Firstly fine tooling adjustments were needed. The European design of the programme was not entirely suited to local use. There were thus certain initial programming difficulties. Secondly there were certain electrical problems that had to be solved. This was done by the technicians in the firm.

As far as the post structure is concerned, no jobs were lost as a direct result of computerization. Six electronic technicians were transferred to the automated new robot plant. Welders, panelbeaters and other skilled artisans were moved to the same jobs in other areas of the factory and the robots did not have any impact on the labour force in the opinion of this respondent. He, however, declined to voice an opinion on how many jobs would have been created, had the robots not been introduced to make the new product.

There are no vacancies at present in the production area. There is however a need for software and hardware analysts and programmers for the management information system. Computer skills are becoming increasingly highly prized.

The jobs of toolmakers and electricians have become more skilled since the introduction of the new technology into production. No jobs have become less skilled because people are moved from one area to another where they can use their skills.

The engineers' and technicians' jobs have become more skilled. In addition to conventional skills, they have had to understand the functioning of computer based machines. Maintenance personnel, in addition to normal apprenticeship training, have also had to learn about pneumatics, hydraulics and the functioning of CNC machines and robots. Foremen and supervisors, skilled artisans and semi-skilled assemblers and packers receive internal training on the operation of the new machines. The technikons are updating their courses to accomodate the use of the new technology. The Council for Scientific and Industrial Research is also involved in the training of the staff in conjunction with the training department of the firm.

When the workers were informed of the change, the management called in the trade union. Meetings were held with union representatives and with the workers' representatives. The union was consulted regarding rates of pay for particular jobs. The respondent feels

that there have not been any negative reactions to the new technology on the part of the staff. The initial fears of job losses have not materialized. Many of the workers are trying to prove that the work they produce is just as good as that done by the robots and a competitive spirit has been encouraged in the firm. However, it is impossible to verify the accuracy of these claims of a contented work force without speaking to the workers.

A number of advantages of the new technology to this company were pointed out. Economically, in the long term there will be savings in labour costs. Administratively, there is less paper work and there is immediate access to information and saving of time. The supervision of staff is much easier as there are fewer people requiring supervision. In general, productivity and quality have improved. It is easier to schedule production flows and volumes. A superior product is now made.

There were however a number of disadvantages too. The initial purchasing and set-up costs are high. An equipment breakdown causes a total shutdown. Production is delayed and production schedules are thrown out. In administration there are periodic record wipeouts when the computers are not working. Data have to be recaptured.

As far as marketing the new product and competition with other firms are concerned, it is problematic to convince the public of the better quality of the robot assembled car. Customers lack the knowledge to realize that the new car is a much better product. The advantages of the new technology are not evident to them.

In future the company plans to introduce a larger mainframe computer and to extend the computerized management facility. It also plans on installing more CNC machines. The current disinvestment campaign could influence the ability to obtain and maintain the new technology in future. The exchange rate will also affect what the company can afford in future.

In spite of the rosy picture painted by this respondent of the effects of the new technology on the work force, one thing is very clear. No new jobs are being created. Semi- and unskilled workers will struggle to find work in the motor industry in future if the trend towards automation continues. The large number of people entering the labour force with no marketable skills is cause for concern. The traditional absorbers of this work force, namely the secondary manufacturing industries, will increasingly become less able to do so if the trend towards more automation is continued. The positive attitude of management towards it indicates that new technology is here to stay. Unless new outlets can be found to buy more products, the work force in the motor industry is likely to get smaller.

CHAPTER 9

CONCLUSIONS

The new technology has many advantages from management's point of view. In all the firms interviewed, the opinion was expressed that a consistently better quality product is made more rapidly than previously. Table 1 indicates the extent to which respondents in management positions agreed or disagreed with a number of statements concerning the effects of the new technology. This table indicates that all the respondents either agreed or strongly agreed with the following statements: the new technology helps to identify inefficiency; it helps to improve productivity; it improves the quality of existing goods and services; it speeds up the production process; it improves competitiveness; it improves the productivity of machines and it improves standards of production. In other words, the new technology is fulfilling its function. It is improving the quality of manufactured products, while at the same time productivity is increased.

Regarding the use of computerization to improve management skills, six of the seven respondents agreed or strongly agreed with the following statements: programmable technology helps management to make better decisions; it makes more information readily available to management; it improves productivity and it improves routine administration. New technology when used as a management tool, is also meeting the needs of the respondents in management positions.

TABLE 1

ADVANTAGES OF THE NEW TECHNOLOGY

	Strongly disagree		N		Strongly agree
	1	2	3	4	5
Programmable technology helps management to make better decisions			1	1	5
It makes more information readily available to management			1	3	3
It helps in the supervision of staff	1		2	4	
It helps to identify inefficiency				2	5
It helps to improve productivity				2	5
It helps to identify effective work			2	3	2
It improves routine administration			1	3	3
It improves methods of production		1		1	5
It improves methods providing services to customers	1	1	1	4	
It improves communication within the organization		1	4	2	
It allows for the addition of new goods and services to the range	1	3	1	2	
It makes it easier to modify goods and services	1	2	3		1
It improves the quality of existing goods and services				2	5
It reduces labour costs			1	1	5
It reduces other costs		3		3	1
It reduces staff turnover	1	1	1	4	
It reduces the need for skilled and semi-skilled labour	2		2	3	
It speeds up the production process				3	4
It is difficult to find the mistakes in the programme		3	2	2	
It is difficult to correct mistakes	1	3		2	1
It destroys creativity	5	2			
It increases costs	4	1	1	1	
It is difficult to implement	2	1		2	2
It adversely affects employment	2		3	2	
It improves competitiveness				6	1
It reduces the cost of maintenance	2	1	2	1	1
It improves the productivity of machines				4	3
It increases the availability of materials	3		2	1	1
It improves standards of production				4	3
It makes data easily accessible	1		2		4

As far as cost effectiveness of the new technology is concerned, no quantitative data were made available. However, six of the seven respondents indicated that labour costs are reduced by installing the new technology. Five strongly agreed with this statement. The respondents varied in their response to the statement that other costs are reduced as three respondents disagreed, three agreed and one strongly agreed with it. However, overall costs are not increased by introducing the new technology as only one respondent agreed with this statement. From these replies one can conclude that savings are taking place in these organizations in the form of manpower cuts. It also means that overall, fewer people are being employed in these firms as more technology is introduced. In the long term, buying the new equipment is more economical than paying labour for doing the work.

If labour saving costs are seen in the light of the greater efficiency of the new technology, then it seems highly likely that the use of it will gain increasing acceptance in the firms that were studied. According to the theory of diffusion the use of new technology will spread relatively rapidly to other users if the experiences of early users are positive. These early adopters tend to be opinion formers.

Economic and political considerations may slow down the rate of acceptance, but the eventual acceptance of computerized technology by large numbers of manufacturing industries is highly likely in view of the positive experiences of the early users.

The full potential of the new technology is not being used. The flexible functions are hardly even recognized. Only two of the respondents agreed with the statement that new goods and services could be added to the range using the new technology. One of the main assets recognized overseas is the adaptability of the new technology to medium size batch manufacture which has led to the development of new goods.

A common problem of management was the difficulty in obtaining suitably qualified or trained people to maintain and repair the new equipment. The lack of highly trained technical staff requires a massive training input in the future.

From the workers' point of view, the new technology can offer new challenges to the people who learn to use it. New employment opportunities are available. For some workers, noticeably those working side by side with machines on a computerized assembly line, the work has become deskilled. Mentally though it is more stressful as more vigilance is required. In fact, increased alertness is an aspect of work found in all new technologies discussed. In contrast to respondents in management who all either disagreed or strongly disagreed with the statement that new technology destroys creativity, most of the workers stressed that work, using the new technology, was less creative because the machine, and not the person, dictates how the work is to be done. The workers' role becomes a monitoring one.

Some workers however found that their work had become more skilled. This applied particularly to those firms where some members of staff had learned to operate more than one machine. For some workers, the initial challenge of learning something new was replaced by boredom, once the basic techniques had been mastered. Rotation of jobs is one way of solving this problem.

It was relatively easy learning to use the new technology. Learning basic robot operation took only one week. It took longer learning to operate the NC and CNC machines. Direct experience contributed to proficiency. All respondents wanted the opportunity of learning how to use the new technology because they felt that they would more easily be able to get a new job if they did so. The general opinion of the workers was that jobs would be lost if the use of the new technology spread in manufacturing industries. One thing that everyone agreed with, was that the way in which work was done

changed markedly with the introduction of computer based automation.

How realistic are the fears of the workers that jobs will be lost by the introduction of microcomputers into manufacturing industries? It needs to be recognized that one of the consequences of greater computerization in manufacturing industries is that employment patterns are likely to change. In the firms interviewed, no staff had actually lost their jobs as a result of the introduction of the new technology. The number of posts was reduced through natural attrition rather than through a redundancy policy. Nevertheless very few new jobs were being created. This is in keeping with overseas findings. For example Northcott et al (1985) found that the feared massive unemployment brought about by computerization has not materialized. Instead a few jobs are lost in certain categories of work. The OECD publication Micro-electronics, robotics and jobs (1982) indicates that employment has been negatively affected by the new technology, but so far this effect has been relatively slight. These effects, according to the OECD report, can be gleaned from case studies, rather than from overall employment figures, where it is difficult to disentangle the effects of other variables on employment from the effects of computerization. It seems as if the dull, repetitive and monotonous jobs are being lost (Ulrich,1983) rather than the more challenging ones. However, the jobs of skilled artisans,in addition to semi and unskilled labourers are being affected. The shortage of skilled artisans in South Africa at the present time means that it is unlikely that many skilled artisans stand to lose their jobs if machines replace some skilled labourers. Semi- and unskilled workers are far more likely to be affected and in South Africa, most of the work in factories is done by unskilled and semiskilled workers.

Even if relatively few jobs are being lost through the new technology, very few new jobs will be created for semi- and unskilled workers, if the trends indicated by the respondents in management are accurate. These trends dó reflect what is happening overseas.

In the past, manufacturing industries, rather than mining or agriculture, have provided some possibility of better living standards for blacks. Jones (1986) points out that in South Africa between 1919 and 1976 the manufacturing industrial sector provided many job opportunities. The mining sector relied on contract labour from nearby countries, while local people were employed in secondary manufacturing. Indeed, it was the main sector in which average black wages continued to increase in real terms, despite some setbacks such as occurred in the depression years. This sector was able to absorb a large proportion of black workers seeking jobs in the cities. No doubt these jobs were dull and repetitive and even dangerous but they were a viable alternative to unskilled farm labour.

It seems as if in future this will be less so. The rate at which employment opportunities are being created in manufacturing industries is decreasing. Fewer jobs in manufacturing is a feature of Western societies (Northcott et al, 1985). It is essential to enable those people who would have gained employment in manufacturing industries to find work elsewhere. There is evidence from overseas research to indicate (Handy,1984) that while direct employment may be negatively affected, indirectly employment can however increase. New jobs in the service sector can be created if more wealth is generated by making and selling cheaper but better products to a larger market.

Employment has been increasing in some sectors. Overseas studies indicate that there is an increase in employment of non-production workers (Peichinis 1983). Administrative, managerial, professional and technical jobs have increased significantly over the past 20 years. These jobs require highly trained people to fill them. The lack of highly skilled manpower in South Africa means that redeployment of people from production to non-production occupations just cannot occur without a massive expenditure on training.

Another feature of new technology is that new skills have to be learned on a continual basis. Adult training as an ongoing process

is becoming very important. An interesting feature of this study was that it illustrated that it is relatively simple to learn to operate computer based machines. Yet these easily acquired skills are highly sought after. Training organizations should be made aware that the skills required in the operation of future automated factories are relatively simple to teach and to learn. However, more complex skills are needed for the development of suitable software and suitable programmes for the efficient functioning of computer based machines. There is a dearth of people who can diagnose faults in, repair and maintain the new technology. Training of technicians who can do this is becoming an important priority.

Local research and development (R&D) so that products suited to local needs are made is another important but neglected area. The interviewed respondents in management indicated that almost no time is spent in their firms on research and development. The firms whose parent companies are situated overseas, indicated that most of the R&D is carried out in those countries. The South African study group on industrial development (Kleu report) confirms that there is very little R&D being done locally. This means that South Africa relies to an increasing extent on imported technology. The report recommends that private industrialists should become more involved in research, that requirements of the marketplace be taken into account in existing research projects and that research findings should be put to practical use. A need exists in South Africa for effective intermediaries for the transfer of research findings from the sources to the industrialists.

Another finding of this study is that most of the firms who had introduced the new technology had not expanded their markets. They were using more efficient means to manufacture the same amount as previously. Only one firm indicated that it had expanded its market since computerization. If new markets are not found, new job opportunities are then not created.

An area for concern isolated in this study is that of lack of communication of change between management and workers. This lack of communication and the lack of involvement of the workers in the change process can cause industrial relations tensions.

A better understanding of the new technology by managers and workers alike will mean that its flexible functions will be more fully used. It will then be possible to make new products. As a starting point the vendors of the equipment need to know more about how the flexible functions of the equipment can be used, so that they can alert potential buyers to these functions. The only way in which a robot can be fully used is by programming it to carry out more than one task.

The introduction of programmable technology into manufacturing industries presents exciting challenges to engineers, technicians and those workers directly involved in its use. It also presents challenges to economists and social scientists to study and understand the implications.

APPENDIX A:

QUESTIONNAIRE A

Office use

1 Name of firm ..... | 1 | Card No.

1.1 Address: .....

....

..... | | | | 2-4 Respondent No.

1.2 Telephone number: .....

2 BACKGROUND INFORMATION CONCERNING THE ESTABLISHMENT

2.1 Description of the work done

.....

.....

..... | | | | 5-7

2.2 Type of establishment:

Factory	1	
Warehouse	2	
Workshop	3	8
Other (specify).....	4	9-10

2.3 Type of concern:

Independent firm	1	
Head Office of a larger firm	2	
Branch of a larger firm	3	11

If Head Office or Branch, does the firm have any overseas connections? Yes | 1 | No | 2 | 12

If yes, please describe them .....

..... | | | 13-14

If independent firm: how are records regarding stock, sales, staff, etc. kept? .....

..... | 15

If Head Office: How is information on stocks, sales and other activities stored and communicated to branches?

Office use

.....

..... 16

If Branch: How is information on sales, stock, workers records and other activities recorded, stored and sent to head office and other branches?

.....

..... 17

2.4 Type of manufacturing industry. (Tick appropriate square)

Food beverages and tobacco industries		1
Textile, wearing apparel and leather industries		2
Manufacture of wood and wood products (including furniture)		3
Manufacture of paper and paper products, printing and publishing		4
Manufacture of chemicals and of chemical, petroleum, coal, rubber and plastic products		5
Manufacture of other non metallic mineral products (china, glassware etc.)		6
Manufacture of basic and fabricated metal products (iron, steel and non ferrous)		7
Other manufacturing industries (specify)		8

18-19

2.5 Type of production. (Tick appropriate square)

Jobbing		1
Batch		2
Repetitive		3
Process		4

20

3 WORK ACTIVITIES

3.1 What products are made by the establishment?

.....

..... 21-23

3.2 What services are offered by the establishment?

.....

..... 24-26

3.3 Main work activities carried out at the establishment.

	Yes	No	If yes % of time per month spent	Office use
Research and development	1	2		27 28-29
Design	1	2		30 31-32
Fabrication of products	1	2		33 34-35
Assembly	1	2		36 37-38
Handling of materials	1	2		39 40-41
Storage	1	2		42 43-44
Distribution of products	1	2		45 46-47
Repairs and servicing	1	2		48 49-50
Installation and maintenance of machines	1	2		51 52-53
Data processing	1	2		54 55-56
Training	1	2		57 58-59
Management and administration	1	2		60 61-62
Other (specify)				
.....				63-64 65-66
.....				M229 77-80
.....				

4 EMPLOYMENT

How many people are employed in each of the following categories?

	Male N	Female N
Professional (e.g. engineer)		
Executive and managerial		
Administrative		
Clerical and secretarial		
Data Processing staff		
Technicians and technologists		
Sales personnel		
Foremen and supervisors		
Skilled artisans		
Maintenance staff		
Semi-skilled workers		
Operators		
Assemblers		
Inspectors		
Unskilled workers		
Labourers		
Cleaners		
Other (Specify).....		

Office use

2 Card No
1 Repondent No
2 - 4
5-6 7-8
9-11 12-14
15-17 18-20
21-23 24-26
27-29 30-32
33-35 36-38
39-41 42-44
45-47 48-50
51-53 54-56
57-59 60-62
63-65 66-68
69-71 72-74
M229 77-80

3 Card No
1
Respondent No
2-4
5-7 8-10
11-13 14-16
17-19 20-22
23-26 27-30
31-34 35-38
39-41 42-44
45-47
M229 77-80

5 WORK PROCESSES

	Tools and machinery used	Is programmable technology used?	Office use 4 Card No 1 Respondent No 2-4
Materials Handling			
Handling of goods and materials in factories			
Storage and warehousing			
Storage retrieval			
Moving and conveying			
Machine loading and unloading			
Other			5-6 7
Designing and drafting			
Design			
Geometric modeling			
Calculations e.g. weight, volume, surface area			
Kinematics			
Drafting drawings for use in manufacture			
Simulation			
Storage of drawings			
Other			8-9 10
Cutting and forming			
Metal cutting			
Glass cutting and forming			
Woodworking			
Fabric cutting			
Plastic injection			
Drilling			
Tooling			
Forging			
Casting			
Moulding			
Other			11-12 13

	Tools and machinery used	Is programmable technology used?	Office use
<u>Joining, Assembly and Finishing</u> Assembling Spot welding Arc welding Spray painting Buffing and polishing Other			14-15 16
<u>Filling packaging and Labelling</u> Palletising Pouring Filling Packagings Sealing Gluing Labelling Other			17-18 19
<u>Testing sampling and inspecting</u> Weighing and measuring Flaw detection Quality control Sampling Other			20-21 22
Cleaning			23-24 25

	Tools and machinery used	Is programmable technology used?	Office use
<u>Control of processes</u>			
Temperature control			
Vibration analysis			
Fluid or metal flow control			
Power supply			
Atmosphere control			
Oil/chemical analysis			
Pressure control			
Condition monitoring			
Timing devices			
Predictive maintenance			
Other process control			26-27 28
<u>Production control and planning</u>			
Planning flow of work			
Planning and scheduling processes			
Planning manpower requirements			
Recording labour used			
Planning materials requirements			
Monitoring work in progress			
Inventory management			
Estimating quantities			
Estimating costs			
Production of works orders			
Estimating times			
Bar codes			29-30 31

	Tools and machinery used	Is programmable technology used	Office use
Other industrial processes			32-33 34
.....			35-36 37
.....			38-39 40
.....			

6 DECISION TO INTRODUCE PROGRAMMABLE TECHNOLOGY

6.1 Please describe how the decision was made to introduce the new programmable technology for each process

	How was the info gained?	Who decided?	
Materials handling			41-42
Designing and drafting			43-44
Cutting and forming			45-46
Joining assembly and finishing			47-48
Filling, packaging and labelling			49-50
Testing sampling and inspecting			51-52
Control of processes			53-54
Maintenance			55-56
Production control and process planning			57-58

6.2 Who was consulted?

Management	1
Technical staff	2
Outside consultant	3
Other workers	4

59

Other (please specify) .....

..... 60-61

Are the different technologies linked into a system? Yes ☐ No ☐

If yes please describe the type of system .....

.....

.....

Office use

62

63-64

M229 77-80

6.3 To what extent did each of the following influence your decision to introduce programmable technology into the establishment?

5 Card No 1

Respondent No 2-4

	Not at all 1	2	3	4	Very much 5	
Improved supervision						5
Increased record accuracy						6
Shorter manufacturing times						7
Improved quality of products						8
Improved efficiency						9
Greater product options						10
Improved productivity						11
Improved labour stability						12
Increased output						13
Reduced labour costs						14
Saving on materials						15
Increased flexibility						16
Elimination of dangerous jobs						17
Elimination of tedious jobs						18
Increased competitiveness						19
Other (please specify)						20-21

22

6.3 Were any new products or product functions developed related to the introduction of computerized technology?

.....

.....

..... 23-24

6.4 What, if any new markets or customers were found for these products?

.....

.....

Office use

25-26

7 TYPE OF PROGRAMMABLE TECHNOLOGY WHICH HAS BEEN INTRODUCED

Which of the following do you use at this establishment?

Please indicate whether or not you make use of the following programmable technology and, if yes, the extent to which you do so.	Never	Rarely	Monthly	Weekly	Daily	
	1	2	3	4	5	
Control of machine tools via numeric control (NC)						27
direct numeric control (DNC)						28
computer numeric control (CNC)						29
Computer aided inspection (CAI)						30
Computer aided design (CAD)						31
Computer aided manufacture (CAM)						32
Combinations of CAM/CAD						33
Computer kinematics						34
Robotics						35
Automated storage and retrieval systems						36
Flexible manufacturing systems (FMS)						37
Process sensors and controllers						38
Computer aided training						39
Computer management systems (materials requirement planning, just in time manufacturing)						40
Computerized data capturing						41
Other computerized technologies						42
Please specify).....						43-44
						45
.....						46-47
						48
.....						49-50
						51

8 INSTALLATION, PROGRAMMING AND MAINTENANCE

		Office use
8.1	Did the new equipment replace existing equipment or did it supplement the older equipment?	52
8.2	Was a cost justification carried out before purchase?	53
8.3	Were there any hidden costs?	54
8.4	How was the equipment installed?	55
8.5	Was a training package included with the machines?	56
8.6	Were there any problems experienced with regard to installation?	57
8.7	Were there any initial programming problems?	58
8.8	Who programmes the equipment for new processes?	59
8.9	Are there any problems experienced with regard to changing the programme for new processes?	60
8.10	Who maintains the equipment?	61
8.11	Are there any problems with regard to maintenance?	62
8.12	What support does the supplier of the equipment offer concerning maintenance?	63

9 POST STRUCTURE

Office use

Please list below all new posts, if any, that have been created since the introduction of programmable technology

Name of post	Number of people employed	How were they recruited

	64-65
	66-68
	69-70
M229	77-80

6 Card No 1

Please list below all the posts, if any, that have been changed by the introduction of the new technology and the way in which they have changed.

	Respondent No. 2-4

Name of post	Type of change	Number of people involved

	5-6
	7-8
	9-10
	11-12

How was the change implemented?

Name of post	Number of people involved	Number of people re-deployed	Number of people dismissed	Number of people not replaced

	13-14
	15-17
	18-20
	21-23
	24-26
	27-29
	30-31
M229	77-80

How many if any vacancies are there at present? .....

In which occupations? .....

10 SKILLS

10.1 Please list the basic skills required by the professional staff, the technicians and technologists, as well as the foremen, artisan semi- and unskilled workers who are directly involved in the production process, in order to carry out their work. Then please list any new skills needed since the introduction of programmable automation and any skills made obsolete.

Office use

7 Card No.

	Basic skills	New skills	Obsolete skills	
Professional (e.g. engineer)				
physical skills				5-7
mental skills				8-10
Technicians and technologists				
physical skills				11-13
mental skills				14-16
Maintenance				
physical skills				17-19
mental skills				20-22
Foremen and supervisors				
physical skills				23-25
mental skills				26-28
Skilled artisans				
physical skills				29-31
mental skills				32-34
semiskilled workers				
Operators				
physical skills				35-37
mental skills				38-40
Assemblers				
physical skills				41-43
mental skills				44-46
Inspectors				
physical skills				47-49
mental skills				50-52
Unskilled workers				
physical skills				53-55
mental skills				56-58
Other workers directly involved in production				
1				
2				59-60
3				
4				61-63

Respondents No. 2-4

10.2 In which areas, if any, is there a shortage of skills?

..... | | 64-65

10.3 In which areas, if any, is there an excess of skills?

..... | | 66-67

10.4 Please list any jobs which have become more skilled following the introduction of programmable automation.

..... | | 68-69

10.5 Please list any jobs which have become less skilled since the introduction of programmable automation.

..... | | 70-71

Office use

11 TRAINING | M229 | 77-80

11.1 Please indicate below the required qualifications and training in each category and any new or additiontal training now required to use the new technology

	Basic training and qualifications	New training	
Professional (e.g. engineer)			5-6
Executive and managerial			7-8
Administrative			9-10
Clerical and secretarial			11-12
Technicians and technologists			13-14
Maintenance personnel			15-16
Sales personnel			17-18
Foremen and supervisors			19-20
Skilled artisans			21-22
Semi-skilled workers			
Operators			23-24
Assemblers			25-26
Inspectors			27-28
Unskilled workers			
Labourers			29-30
Cleaners			31-32
Others			33-34
			35-36

8 | 1 | | | Card No

2-4 Respondents No

11.2 Where did the workers receive the additional training required since computerization?

Office use

From the company by inservice training	1	
From courses run by the personnel department	2	
From the vendor of the equipment	3	
From a university or technikon	4	37

Other (specify) .....

..... 38-39

How long was the training programme? ..... years 40-41

What areas did the training cover? 42-43

.....

Which occupations required retraining?

.....

..... 44-45

What training will a new recruit receive? .....

..... 46-47

Who will give this training? .....

..... 48-49

12 INDUSTRIAL RELATIONS

12.1 Who told the workers of the change? .....

..... 50

12.2 How were the workers told of the change? .....

..... 51

Office use

12.3 Were the workers consulted in the decision making process?

Yes 1

No 2 52

12.4 Was there any union involvement with regard to the implementation of change?

Yes 1

2 53

If yes describe this involvement. .....

.....

..... 54

12.5 Describe any positive reactions to the change by the workers.

.....

.....

..... 55-56

12.6 Describe any negative reactions to the change by the workers

.....

.....

..... 57-58

13 ADVANTAGES AND DISADVANTAGES OF THE NEW TECHNOLOGY

13.1 Please list the advantages and disadvantages of the programmable automation in each of the following categories:

		Office use	
General Advantages			59
Disadvantages			60
Economic Advantages			61
Disadvantages			62
Administration Advantages			63
Disadvantages			64
Supervision of staff Advantages			65
Disadvatages			66
Methods of production Advantages			67
Disadvantages			68
Competition with other firms Advantages			69
Disadvantages			70
Other aspects Advantages			71
Disadvantages			72
		M229	77-80

13.2 Please indicate the extent to which you agree or disagree with each of the following statements:

	Strongly disagree 1	2	3	4	Strongly agree 5	Office use: Card No. 9 1 — Respondents No. 2-4
Programmable technology helps management to make better decisions						5
It makes more information readily available to management						6
It helps in the supervision of staff						7
It helps to identify inefficiency						8
It helps to improve productivity						9
It helps to identify effective work						10
It improves routine administration						11
It improves methods of production						12
It improves methods providing services to customers						13
It improves communication within the organization						14
It allows for the addition of new goods and services to the range						15
It makes it easier to modify goods and services						16
It improves the quality of existing goods and services						17
It reduces labour costs						18
It reduces other costs						19
It reduces staff turnover						20
It reduces the need for skilled and semi-skilled labour						21
It speeds up the production process						22
It is difficult to find the mistakes in the programme						23
It is difficult to correct mistakes						24
It destroys creativity						25
It increases costs						26
It is difficult to implement						27
It adversely affects employment						28
It improves competitiveness						29
It reduces the cost of maintenance						30
It improves the productivity of machines						31
It increases the availability of materials						32
It improves standards of production						33
It makes data easily accessible						34

14 FUTURE PLANS FOR FURTHER INTRODUCTION OF PROGRAMMABLE TECHNOLOGY

Office use

Please give a brief description of

The type of equipment you plan to introduce in the next 5 years

.....

.....

..... 35-36

The processes it will affect .....

.....

.....

..... 37-38

The areas of production it will affect .....

.....

.....

..... 39-40

15 Do you foresee any problems in obtaining, the programmable technology you require in the future?

.....

.....

..... 41

16 Do you foresee any problems in maintaining the existing technology in future?

.....

.....

..... 42

17 Do you foresee any problems in updating existing equipment in future?

.....

..... 43

M229 77-80

APPENDIX B:
QUESTIONNAIRE B

INTERVIEW SCHEDULE FOR WORKERS

		Office use
		1 Card No.
		2-4 Respon-dents No.
1	Your present occupation Please give a functional description of your present occupation (for example welder involved in arc welding).	
	_____	
	_____	
	_____	5-6
2	Work activities Please describe the work activities carried out by you on a typical working day.	
	_____	7-8
	_____	9-10
	_____	11-12
3	Machinery and tools Please describe the machinery and tools that you use to carry out these work activities.	
	_____	13-15
	_____	16-18
	_____	19-21
	Are any of these machines and tools programmable? Yes 1 / No 2	22
	If yes; please describe the type of programmable equipment that you use.	
	_____	
	_____	
	_____	23-25

4 Skills

Please describe the skills that you need to carry out your work activities.

Office use

_____ 26-27

5 Knowledge

What theory and background knowledge do you need to carry out your work?

_____ 28-29

6 Change in skills and knowledge

Have the skills and knowledge required of you to carry out your work changed in any way since the introduction of computerisation in the workplace?

Yes	1
No	2

30

If yes; please describe the change.

(a) Skills _____ 31-32

(b) Knowledge _____ 33-34

7 Training

What initial qualifications did you need to do your present job?

_____ 35-36

Office use

Where did you receive your initial training? _____ | | 37-38

_____ | | 39-40

Have you received or are you receiving any training so that you can use the new computerised equipment?

Yes	1
No	2

	41

If yes:

Where do you receive this training? _____ | | 42-43

Who gave you the training? _____ | | 44-45

How long did this training take? _____ | | 46

Describe this training concerning

(a) Operating the machines _____

_____

_____ | | 47-48

(b) Programming the machines _____

_____

_____ | | 49-50

(c) Maintaining the machines _____

_____

_____ | | 51-52

8 Communication of change

When new technology was introduced into the work place:

Who told you about the change? _____ | | 53-54

How were you told of the change? _____ | | 55-56

Do you belong to a trade union?

Yes	1
No	2

	57

If yes; was the trade union involved in negotiations concerning the implementation of the new technology and its effect on the workers?

Yes	1
No	2

Office use 58

Do you know if there was any form of negotiation with the workforce?

Yes	1
No	2

59

If yes, describe the negotiation that took place

_____

_____

_____ 60-61

9 Your feelings

How did you feel about the change when it was introduced?

_____

_____

_____ 62-63

How do you feel about it now?_____

_____

_____

_____ 64-65

Please list any advantages for you personally of the new technology.

_____

_____

_____ 66-67

Please list any disadvantages for you personally

_____

_____

_____ 68-69

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10 Your opinions

Please indicate with which of the following groups of two statements you agree and with which you disagree.

Office use

2 | Card No.

Respon-
2-4 dents No.

The new technology makes work more interesting [1]

It makes work more boring [2] 5

Reason for your answer _____

_____

_____ 6-7

It increases responsibility of the workers [1]

It decreases responsibility of the workers [2] 8

Reason for your answer _____

_____

_____ 9-10

It makes more jobs available [1]

It takes jobs away from people [2] 11

Reason for your answer _____

_____

_____ 12-13

It makes the work less dangerous [1]

It makes the work more dangerous [2] 14

Reason for your answer _____

_____

_____ 15-16

Office use

It creates opportunities for promotion 1

It limits opportunities for promotion 2 17

Reason for your answer_____

_____

_____ 18-19

It increases stress placed on the worker 1

It decreases stress on the worker 2 20

Reason for your answer_____

_____

_____ 21-22

It increases the workload 1

It decreases the workload 2 23

Reason for your answer_____

_____

_____ 24-25

It makes physical tasks easier 1

It makes physical tasks more difficult 2 26

Reason for your answer_____

_____

_____ 27-28

It helps to improve productivity 1

It adversely affects productivity 2 29

Reason for your answer_____

_____

_____ 30-31

Office use

It causes inefficiency 1

It helps to overcome inefficiency 2 32

Reason for your answer_____

_____

_____ 33-34

The machines are easy to maintain 1

They are difficult to maintain 2 35

Reason for your answer_____

_____

_____ 36-37

They are easy to operate 1

They are difficult to operate 2 38

Reason for your answer_____

_____

_____ 39-40

They are easy to programme 1

They are difficult to programme 2 41

Reason for your answer_____

_____

_____ 42-43

They allow people to be more creative 1

They destroy creativity 2 44

Reason for your answer_____

_____

_____ 45-46

They improve standards of production | 1

They diminish standards of production | 2

Office use

47

Reason for your answer_____

_____

_____ 48-49

It makes it easier to introduce new goods | 1

It makes it more difficult to introduce new goods | 2

50

Reason for your answer_____

_____

_____ 51-52

Please complete the following sentence.

New technology in the workplace has meant that_____

_____

_____

_____

_____ 53-55

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