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The factory of the future and the future of work

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The factory of the future and the future of work

Will there ever be unmanned factories in which self-regulating production systems design products, obtain the materials needed to manufacture them and supply a constant stream of new goods and services to a steadily expanding market on the basis of decisions taken at some remote point?

Will flexible manufacturing systems aided by highly integrated computer systems adapt ever more quickly, cheaply and efficiently to consumer requirements that change with increasing speed, becoming more demanding at each stage?

Will there be a new division of labour between man and machine, and will work be so organized that man again becomes master of the machine rather than a mere operator or appendage?

Is the greater productivity induced by new production systems and the associated working conditions leading to a new wealth of freedom, more independence and peaceful co-existence between man and regions, between rich and poor, North and South, East and West?

These ideas mooted by technocrats and others who yearn for harmony, are they realistic? Are they not at variance with the fact that technology has always had something to do with power, with the investment of capital and with control over man and nature?

Were the principal driving forces behind the development of computers and numerically controlled machine tools not the military strategists who had urged the development of nuclear technology?

Have the main arguments of stockholders and managers for the introduction of technology not always been that it reduces the error rate, makes them independent of downtime, absenteeism and man's inadequacies, increases productivity and opens the way to dominant market positions?

In mass production, the manufacture of large batches and the primary sector of the economy these arguments no doubt still dominate. As the market becomes increasingly saturated and the importance of demand-oriented small and mini-batches grows because of the quickening pace of change in needs or fashions, the consumer may, however, be winning back some of his power over the market from the large producer, and man is acquiring a new measure of autonomy and creativity in production. Some industrial sociologists refer to this as 'controlled autonomy', probably because data processing makes for constant improvements in control not only over production but over man too.

This edition of *Vocational Training* attempts to clarify what roles human labour and qualifications, initial and continuing training will play in the development, introduction and application of new production systems in the factory of the future. This debate has been prompted in particular by the comparative study of 'Flexible Manufacturing Systems and their Effects on the Organization of Work and Training' carried out for FAST and CEDEFOP by Danish, French and German research teams.*

It is our aim in this edition to continue and supplement the debate sparked off by this study and so provide vocational training experts with arguments in support of an offensive policy on both initial training and continuing and adult education and training.

Although the unmanned factory is feasible for highly specialized small production runs as well as mass production, studies so far undertaken indicate that it is not only undesirable in such cases but also inefficient. Man's creativity, talent for improvisation and responsibility cannot be transposed even to the best of 'highly intelligent' machines. Such qualifications can hardly be reduced to individual steps and converted into programmes for machines. While man may well derive new freedom and latitude from new production concepts, he is also in danger of having his every action monitored, leading him increasingly to conform in his thinking, especially where a restrictive information policy is pursued and a new form of the division of labour gains ground: greater importance must therefore be attached to free access to information and an open information and communication policy at all levels of corporate and social organization. Only where access to information and information itself are subject to a selection process can (unlawful) dominance within an organization continue. The general dissemination of information, however, appears to be the precondition for the efficient organization of work and appropriate exploitation of the potential of the new production systems. Hardly anyone today can evade the growing transparency within such systems, or the growing interdependence it entails. Managers are likely to increase the pressure on employees to remain loyal to the firm, but employees are also likely to call for greater credibility on the part of managers.

A new form of organization of work and production appears to be emerging, one that again focuses on man, with all his strengths and weaknesses. The niches in which technicians and skilled workers were able to deal with things, tools and machines rather than other human beings are becoming less and less common. Is the skilled worker in danger of extinction? Skilled craft work was once transferred to such machines as printing presses and machine tools, and now the skills of designers, setters, management experts and technical draughtsmen are being transferred to computer-aided machines.

This is the real second industrial revolution, which is again threatening to downgrade vocational qualifications. But like the traditional crafts, at least some of which have survived, some of the 'old qualifications' will live on. They will be joined by new ones, but few will be completely new: most will change their content and 'catchment area', attuning themselves to the emerging organization of work and division of labour in the new production systems and to their periphery (see also the article by A. d'Iribarne, p. 7).

For a growing number of employees it is becoming increasingly important to under-

* The findings of this and parallel studies were presented at a meeting held in Turin in 1986, which was attended by many experts from all the Member States of the Community – see also CEDEFOP Flash 6/86.

stand what goes on within a complex production system if they are to use subsystems effectively, to repair and maintain them and to ensure that they operate smoothly. Although there is less demand for manual skills, a knowledge of working and processing methods is generally required of both the production worker and the repair specialist, although the distinction between them is becoming less distinct in many cases. These are examples of current movements, but the direction they are taking is not clear and still varies from one country, one sector and one firm to another. There are, however, signs of a process of approximation in Western Europe, as distinct from the United States and the Far East. This at least is the contention of one of the contributors to this edition. Peter Brödner, who has been observing the development of technology through the eyes of an industrial sociologist for many years (see p. 30)

The change in production methods and especially in the organization of work in firms using new production systems, a subject of growing interest, clearly indicates the need for an extended social dialogue on industrial relations at this particular level of firms. This dialogue would appear to be a major precondition both for product and process innovations and for a further increase in productivity and flexibility in manufacturing. What form the organization of work takes in the future seems to be a key question, one on which the introduction and success of the new technologies will largely depend.

As early as 1982 CEDEFOP was stressing that there are only 'indirect links between a given job and the content of training', and this leads us to emphasize once again:

■ Training will have to cover a wider field than in the past: skills should take in elements of a number of traditional occupations, and knowledge is becoming more important.

■ The nature of the relationship between education, training and firms and their environment will change, and the focus is likely to shift to the question of their cohesiveness and cooperation in terms of both the necessary links among them and the importance and roles of the various parties involved and of the content of the agreement reached by those responsible for training.

The purpose of this edition of *Vocational Training* is to indicate, through contributions from various authors, the most important trend in the debate on vocational training, which is increasingly concerned with teaching people skills rather than adapting them to the new technologies. The articles provide sufficient material for an edition devoted to the one subject and supplement the discussions that have formed part of CEDEFOP's past acitvities (especially the CEDEFOP conference on 'New Technologies' in 1982 and the results of the 1st European Congress on Continuing Education and Training held in Berlin in 1986).

GEORGES DUPONT and BURKART SELLIN

Technology, work and employment – New trends in the structural change of society

Werner Wobbe

Technological change has been largely construed by social researchers as an industrial phenomenon of mass production. Computer-aided information technology was seen as no more than a further refinement of the conventional electromechanical automation technology of the factory: the trend towards full automation was otherwise proceeding as normal. Forms of production which did not comply with these 'laws' of large-scale industrial technology were regarded as 'doomed to extinction' and residual. Work, employment and the development of skills were interpreted in the same context. The narrow view taken of technology has made it difficult to understand the structural change of Western European societies and its likely future trends. It is assumed in the following that in the industrial core sector forms of production involving 'flexible specialization' are a challenge to Western Europe which will make greater demands on work and vocational training than conventional mass production.

Organization rather than technology is a key element for the human capital of the future. The structure of society is changing into a meta-industrial system sustained by an industrial core employing relatively few workers and by a periphery of industrial services. In training greater account must be taken of the lines of communication and organizational skills that span the boundaries between these employment sectors.

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These are the initial conclusions drawn from the FAST subprogramme entitled 'The Relationship between Technology, Work and Employment', which, when completed, will cover 12 areas of research and produce four strategy dossiers.[1] The programme is concerned with advances in the automation, communications and optical technologies (lasers, sensors, etc.) and new materials, where the aim is to gauge industrial implications and work problems. Studies are also being made of key groups in social innovation, such as 'brainworkers' or systems innovators, teachers and trainers working in the field of information technology. The research findings of the FAST programme will eventually be pooled so that work and employment scenarios can be developed and future options inferred from them. In the final analysis, political decision-makers face the task of setting the scene either for employment opportunities to be concentrated in the consumer service sector, with comparatively inferior working conditions, or for education and training to be broadened and employment stimulated by intelligent forms of production.

Meta-industry

Industry has not been a major source of employment in any of the developed countries for at least 20 years. In the United States of America it provided only 28 % of all jobs in the early 1980s, as against 35 % in the Community of the Ten.[2] Yet it would be wrong to speak of service societies, even though the service sector has become dominant in both employment and value terms. The hope of 'reindustrialization through high technology' is not a long-term concept for resolving work and employment crises – at present this advanced sector accounts for only 2 to 5 % of employment in the most developed industrial countries[3] – nor is linear growth of services a productive prospect: after all, the various types of services – e. g. health and social services, transport and communications, consumer and domestic services, government services, industrial services and their many subdivisions – are far too disparate to be significant. It must also be asked for whom and for what services are rendered and, above all, on which sectors of society they intend to subsist.

The wealth-generating core of our societies – FAST sudies show[4] – will continue to be located in core industry for the next two decades, but it will consist of a changed industrial structure and in an 'alliance' between industry and industrial services. FAST therefore refers to a meta-industrial system, a term that is designed to reflect the structural changes that are occurring.

Distance working and industrial services

Although structural change also has a technological component, it is primarily related

Produktionstechnisches Zentrum, Berlin.

to the reorganization of the work and employment components interacting with entrepreneurial units. The question is how work components and product components can be integrated to form a whole. There is empirical evidence that industrial employment in the narrower sense is declining and employment in the industrial service sector is expanding. The growth sectors include research and development, computer software, sales advice, accounting/auditing, engineering, consultancy, data banks, etc. In the industrial service sector and cooperation with industrial companies recent developments in the field of telematics, the combination of information and communications technologies, appear to be playing a key technological role. They form the basis of 'distance working'.[5]

While trade unions today place the main emphasis on the problems connected with electronic homework done by unskilled women, corporate decision-makers are anxious about problems connected with the supervision of such forms of work. These problem areas, which should certainly not be underestimated, fail to reveal, however, the considerable organizational requirements of such forms of cooperation.

Technical advances have shifted the emphasis from data input to those who actually provide the services and are already working with telematic equipment, examples being systems analysts, sales engineers, data bank creators and editors. Little has so far been done to develop the qualification and vocational training components, including distance learning courses, and in view of the strategic importance of this sector, they need to be reconsidered.

Networks and systems innovators

The gradual development of technical networks within and between companies has an important facet for certain groups of people. In the telematics sector a key role is played by 'brainworkers' or systems innovators. They can be described as a group of people who translate complex information processes 'creatively into systems-oriented, technological innovations' where their translation into social work relationships cannot be avoided.[6] They are thus responsible for the development, implementation and innovation of such complex telematic forms of cooperation as CIM (computer integrated manufacturing) and the integration of office and factory automation. Technical components are currently adjusted to existing forms of social organization (or vice versa, as has often been attempted) by systems analysts, information technology or telematics specialists, systems planners, software or automation specialists, i. e. by personnel with a predominantly technical training. The social or socio-organizational side of their task was ignored during their training. The failure of people and systems where implementation has been tried bears witness to this deficiency, as does the inadequacy of systems designs. Added to this, firms are organized bureaucratically and hierarchically, with strict lines of demarcation between areas of responsibility, which conflicts with the all-embracing nature of the activities of this group of people. It is not only negotiations, management and the organization of complex innovations that seem likely to be a problem in the future, but also and above all the training of systems specialists. The public training institutions have not yet reacted. The predominantly technocratic thinking of the traditional training institutions of the universities in the technical subjects and information technology does not augur well. The private sector currently appears to be tackling this deficiency, as new institutions spring up in cooperation with information technology firms, and the public training sector is consequently in danger of becoming antiquated.

To summarize, it can be said that not only do companies face new problems in the areas of organization and cooperation due to the structural change to meta-industry and industrial services, but that greater attention should also be paid to the implications of these problems for qualifications and training.

Organization: a key component of production

Industrial companies did not regard organization as a challenge as long as they could copy traditional concepts of bureaucracy and hierarchy. Conventional mass production, supported by an extensive division of labour, was able to apply these concepts without difficulty. In the future, however, conventional mass production in Western Europe is likely to be forced into the background. Economic constraints imposed by the world market and the international division of labour, not only between Europe, the USA and Japan but increasingly and particularly with such Pacific Basin countries as South Korea, Taiwan, Hong Kong and Singapore, are causing Europe to draw on the former strengths of its engineering industry and skilled labour force and go in for more specialized product lines. Products which appear to have a particularly good future are:

- complex, customer-oriented, high-quality products,
- manufactures requiring little maintenance and servicing,
- highly flexible production systems which ensure punctual delivery.

The European capital goods industry is a prime candidate because it has flexibility, organizational know-how and appropriate human capital. This sector of industry, and others too, should be preparing for the form of production known as 'flexible specialization',[7] which has wide-ranging implications for organization and qualifications. This was stressed in the findings of the joint research activities of FAST and CEDEFOP presented at a conference of experts in Turin.[8]

Flexible specialization as a concept for the future

Knowledge-based, high-quality, customer-oriented production of small batches has tended to be regarded as pre-industrial and therefore marginal and ultimately doomed to extinction. It lacked advanced production technology and also plants of an appropriate size. It was only with the advent of microelectronics-based technologies that this sector began to attract more attention, since in principle production did not now need to be adjusted to technology and large batches: appropriate technology could be developed for these specialized product lines. It is thus able to emerge from its 'craft stage' without having to turn into large-scale industry. But even without this technical/economic component small and medium-sized production units and forms of production seem to be gaining in importance and possibly outstripping large-scale production. Only when the essential features of the components of production are compared do the peculiarities of conventional mass production, or Ford-style production, and flexibile specialization become apparent.

Features of Ford-style production and flexible specialization

Ford-style production	Flexible specialization
mass production, large batches	sophisticated, high-quality products
few production variants	wide range of variants
single-purpose technology	programmable technology
unskilled workers	limited division of labour
simple working conditions	skilled workers
large production units	high wage levels
bureaucratic, hierarchic organization	intelligent organization
relatively limited R&D activities	intensive development work
	small production units
	quality-based competition

This simple comparison of basic features might wrongly be understood as implying that mass production has no future and that flexible specialization is advocated as a special form of craft production. To avoid this misconception, I will add a further chart to make it clearer that flexible specialization can also be regarded as a modifying factor for mass production which develops from the old, very conventional Ford style of mass production into a new type that produces a range of high-quality products and thus adapts elements of flexible specialization.[9] In the car industry there are examples of a strategy of changing production in this direction (very pronounced at Daimler Benz and Volkswagen, for example). Where products are manufactured in small and medium-sized batches, the term 'skill-based technological production' would be more appropriate because it expresses the idea that small-batch production along the lines of flexible specialization must apply the latest concepts, such as computer technologies, if it is to overcome the inefficient organization of traditional old and small firms.

Production strategies

Batch size	Standardized products in price-based competition	Customer-oriented products in quality-based competition
small ↓	production with specialized components	production by craftsmen
	mail-order production	skill-based technological production
large	mass production	diversified high-quality production

We are thus able to conclude that 'flexible specialization' influences both mass production and the production of small batches. Of both types of production it can be said that a wide range of high-quality products calls for a greater development effort, highly qualified workers and intelligent organization to permit a flexible response to rapidly changing market conditions and customer requirements.

CHIM (computer and human integrated manufacturing)

The CIM (computer integrated manufacturing) concept reflects the revival in recent years of an old technocentric production ideal: the unmanned factory, now equipped with the very latest means of computer control. This tradition of technocentric thinking leads industrial and research policies down the wrong road because it suggests that human labour should in principle be excluded from production. The FAST/CEDEFOP research on flexible manufacturing systems (FMS)[10] has clearly revealed that, unlike previous automation technologies, which attempted to replace human production work with technology, CIM is a communication and organization tool that influences cooperation in and outside companies and so makes greater demands on human labour at both management and shop-floor level. Furthermore, CIM concepts have so far been designed for routine large-batch production and less for the 'flexible specialization' type of production. To reflect the future requirements of production more accurately, we have therefore chosen the term CHIM, standing for 'computer and human integrated manufacturing', in order to demonstrate the interplay of technology, organization and human skills in production. As part of the FAST/CEDEFOP research work a team of experts set the following standard for development and training policies geared primarily to small production units[11] in order to take account of the extreme variation in the demands made by changing production requirements:

■ Development of anthropocentric technologies: In future, machines should not be so constructed that they ideally manufacture only one product and the worker is left to compensate for their weaknesses (residual work). New technologies have made it possible for the machine again to be used by man as a tool, with the worker taking decisions according to his skills and computer programmes providing information on alternatives and implications.

■ Organizational know-how and organizational methods must be developed (orgknow). If the routine and hierarchy of mass production and the chaos of small unorganized firms are no longer wanted, new concepts of organizing production which adapt flexibly to changing requirements need to be developed.

A wider range of qualifications appropriate to constantly changing production must be developed at both shop-floor and management level. The concept of the relatively independent skilled worker, as he is now to be found in German-speaking and some Scandinavian countries, would seem to form a good basis for this.

Conclusion

Future forms of production will certainly not be characterized by 'unmanned factories': on the contrary, the human factor will gain in importance in production systems that employ increasingly complex communication and information technology. Structural change towards a 'meta-industrial system' and 'flexible specialization' is making organization a key factor. The growing importance of organization that adjusts to changing production requirements calls for a body of skilled work, which will necessitate additional training for systems innovators, management and workers. However, the future of European industrial production will also depend on the respective 'production culture'[12] of the Member States of the European Community. The extensive division of labour in Mediterranean countries is not as efficient as holistic production systems in Northern Europe, as the research findings show. It also remains to be seen how far the tradition of industrial relations in the Member States influences the nature of a flexible form of organization, or resists it.

1 See the article by R. PETRELLA in this edition.

2 See Eurostat, Statistiques de base de la Communauté, Edition 1984, Luxembourg.

3 OECD, Technology and Employment, Note by the Secretariat, Draft First Revision, Paris, 12 June 1985, Ms.

4 e.g. SEMA/METRA, Services to the manufacturing sector, a long-term investigation, FAST FOP No 96, Brussels 1986.

5 See E. STERN, R. HOLTI, Distance working study, summary and recommendations for action, FOP No 92, Brussels 1986.

6 See BATELLE, The brainworkers, training background and work situation, FOP No 123, Brussels 1986.

7 P. H. KRISTENSEN, Industrial models in the melting pot of history, FOP No 109, Brussels 1986.

8 See CEDEFOP Flash 6/86, Berlin 1986.

9 See W. STREECK, Neue Formen der Arbeitsorganisation im internationalen Vergleich, Vortrag zur Konferenz 'Zukunft der Automobilindustrie', Wolfsburg, 25 to 27 November 1986, Ms.

10 See, in particular, J. FIX-STERZ, G. LAY, R. SCHUTZ-WILD, Stand und Entwicklungstendenzen flexibler Fertigungssysteme und -zellen in der Bundesrepublik Deutschland, FAST FOP No 89 D, Brussels 1986; M. HOLLARD, G. MARGIRIER, A. ROSANVALLON, L'Automatisation avancée de la production dans les activités d'usinage, FOP No 124, Brussels 1986; B. HAYWOOD, J. BESSANT, FMS in Britain: The good news and the bad, Brighton Polytechnic working papers No 7, Brighton 1986.

11 P. BRÖDNER (ed.), Strategic options for new production systems in computer and human integrated manufacturing: Results of a working party, FOP 142, Brussels 1987; see also his article in this edition.

12 See Fondazione AGNELLI, M. CASOLI, The new factory. Report on the Italian case, contribution to the FAST/CEDEFOP Symposium on New Production Systems, Turin, 2 to 4 July 1986.

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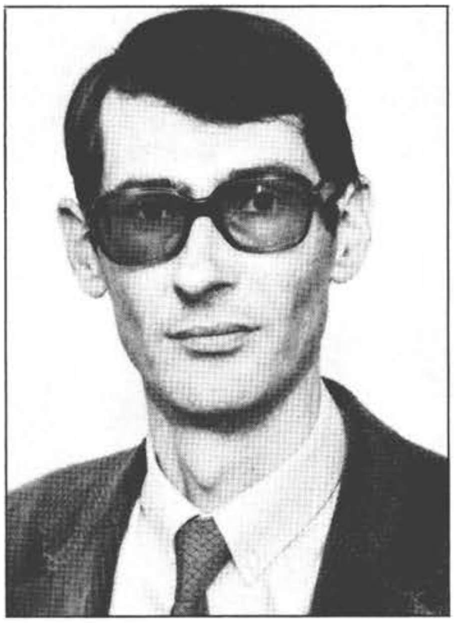

New training and new skills in new factories*

Alain d'Iribarne

The Turin Symposium probably marks a turning point in the European Community's approach to the 'factories of the future'. For the first time, researchers attending the symposium challenged the idea that all factories in the vast range of manufacturing industries will soon be built to the same model: the comprehensive computerized integration of design, machine control, logistics and management, combinig flexible computer-aided control, flexible workshops and computer-aided production management.[1]

They did not dispute that there is a growth in computerized integration, but they argued that it is not a universal model, nor is it rapidly becoming the general rule. Their arguments were based on the observation that in most European countries computerized systems are still on the whole confined to large private-sector concerns.[2] Above all they were based on a desire to define more precisely how these integrated computerized factories can help to achieve a satisfactory solution to the new problems of competitiveness faced by different types of concern: not only the need to cut manufacturing costs and production time and improve product quality but also the problem of flexibility.[3] As an alternative to the model of integrated technological flexibility, they proposed a model based on decentralized organizational flexibility, which they saw as far more likely to solve many of the problems of competition problems.[4] It is increasingly apparent that factories of the future will opt for various combinations of these two models in the future.[5]

The symposium was also a milestone in the approach to the organization of labour, the changing pattern of skills and new training needs associated with those technological developments. Whereas the central debate at the CEDEFOP seminar in Berlin in November 1982 was whether computer technology is leading to 'deskilling' or 'polarization of skills', [6] the main concern in Turin was to identify policies that would promote the acquisition of those technologies at low cost and the same time reduce the risk of a rigid division of labour. This change in the nature of the debate has come about as a result of progress in research, which has clearly revealed the links between technological developments and the methods of labour organization associated with those developments within individual countries and companies on the one hand and, on the other, the skills available and the ways of creating those skills through training. For example, it has become clear that there is a far less marked division of labour within a highly skilled labour force, and that it adjusts more rapidly to technological change.[7] With this in mind, training and skills acquire an entirely new status. With the emergence of the 'new' factories, training and skills are no longer viewed as aids to adjustment but rather as basic factors that will be part of the architecture of future systems.

Before the skills and training needed in the new factories can be assessed, the levels of analysis and the factors to be taken into account at each level must be defined. In determining the operations entailed in a job, the basic knowledge it calls for and its psycho-cognitive aspects, consideration must be given to important factors such as technological developments, organizational models and management practices. When examining jobs and the functions they entail, the main consideration is the organizational model. When, on the other hand, grouping jobs under occupational headings, when determining their classification, occupational category and socio-occupational status and when deciding what training – expressed in terms of general education and specialization – is required for each one, a far more vital factor will be the form of social organization prevailing in each European Community Member State, in other words at a much broader level than the single workplace, with its own individual background.

* This paper is based on the second part of an article by A. d'Iribarne. 'L'ordinateur, l'usine, la culture et les emplois' in Projet, 'Le tout ordinateur', No 201, September/October 1986, pp. 24 – 44.

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The knowledge and abilities required are highly dependent on technological development

The drawbacks of technological specialization

When people discuss new technology they tend to stress the need to acquire technological knowledge in the field – in electronics, optics or programming, for example. In practice, however, this technological knowledge is directly needed by only a few groups of practitioners such as product and production system designers and maintenance specialists. For others, any one technology is just part of a complex technical system embracing a number of technologies.

Their problem is how to master the system and meet its technical, economic and social demands. In acquiring a specialist skill it makes little sense to learn about all the individual technologies on which that skill is based. The knowledge that is acquired about those technologies must be ordered, combined and directly related to the problems to be solved.

More importantly, it is becoming ever harder to understand the way in which new generation systems function. Nevertheless, people must have frames of reference if they are to cope with the jobs they will be called on to do. This means that technology should be an integral part of everyone's basic education, creating what is often called 'technical mindedness'.[8]

Learning to think in the abstract and react on-line

A second approach to the relationship between labour and technology relates to the 'man-machine interface'. The emphasis here is not on the technologies incorporated into equipment but on the development of equipment as 'tools of the trade'. In the computer age, now that it is more and more common for terminals to be interposed between operators and the flow of materials they have to handle, the relationship between people and the products they manufacture is far more abstract and formalized.

The main problem is the form taken by the dialogue between the operatives and the materials being handled via the interface system. Initially this dialogue was off-line. Then it was conducted on-line, first in the conversational mode and now in the interactive mode. The cognitive demands are fundamentally different: someone working off-line had time to reflect, prepare several alternative solutions and then see which was best; on-line interaction replaces that procedure with a direct set of questions and answers based on different cognitive processes. What is now needed is a combination of reflection (research) and reflex (the ability to take immediate action).

The speed of convergent interaction in solving a problem has become an essential skill. To find a solution, the operator has to draw on what is often a large body of formal pieces of information just at the threshold of perception. Since the solution must be found rapidly, 'patterns' must exist to help the operative interpret the signals received and relate them to the problem. This presents trainers with an ever more acute problem of how to provide 'patterns of interpretation' that can be applied to work situations rather than just knowledge. It is, then, all the more vital to incorporate a basic knowledge of working practices into training right from the outset.

Communicating in isolation

The new systems are 'economical' in direct manpower: fewer people are needed on the shop-floor, increasing the risk of physical isolation in vast 'hangars'. The desire to alleviate this isolation is part of the reason for organizing manpower into teams. Such is the paradox of communication technology!

While the work is done in greater physical isolation and offers greater freedom of choice, it is also an integral part of broader and more closely linked information, action and decision networks. This calls for the ability to operate within the bounds of stricter methodological procedures and in a broader production and social space, a space that is intangible and perceived in the abstract.

The abstract conceptual ability needed in computerization and networking is not confined to the ability to grasp the material demands of a job, a piece of equipment or the technology in that equipment, nor to understanding the work space in relation to the product being handled. The conceptual ability must extend to the ability to adapt to new social spaces calling for a broader range of knowledge.

The need to think ahead, not just to react

Operatives and their supervisors are now expected not just to react to events and single incidents but to anticipate them and take action. This broadening of the abilities demanded is radically changing the basic skills needed. Operatives must be capable of analysing and thinking for themselves. In addition to their basic technical knowledge, they must be capable of lateral thinking so that they can apply that knowledge within certain frames of action. They must also

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possess what, for want of a better term, will be referred to as the 'behavioural and attitudinal qualities' of forethought and commitment to the work they do. These will be determined by their 'social skills', their value systems and, in the final analysis, their education. It is altogether logical that the new skills expected of workers extend far beyond technological expertise, raising the question of what basic standard of education is required of skilled operatives.

Artificial intelligence instead of human intervention

Of more relevance to the future than the computerized automation of equipment control and the flow of materials is the development of expert systems of artificial intelligence.[9]

In its present stage, automation is gradually reducing the need for human intervention in the sense of direct physical action, but is increasing the intellectual effort of monitoring and coordination. This is a new step in automation, the aim being to state human physical actions in algorithmic terms, starting with the simplest actions – repetitive tasks that can easily be broken down and defined – and progressing to the most complex actions – unpredictable tasks that depend on 'fluid cognitive processes'.[10] In the long run, this will have major implications for relations between people and their work, since artificial intelligence will no longer be used merely to solve problems associated with fairly complex physical actions but actually to simulate the cognitive processes themselves. Artificial intelligence will reinforce the development of production process regulating systems that combine those stages in which processes are automatically regulated by closed loops, based on elements which can be modelled directly, with more advanced open-loop stages where the focus is on human skill. In the latter stage the operative will have recourse to increasingly sophisticated decision-making aids based on structured data. Having to work to ever more precise standards when he acts on decisions as to regulation and the correction of discrepancies, the operative will have to foresee corrections ahead of the self-correcting mechanisms. His role is bound to grow, in that he will intervene in exceptional circumstances even though the processes are in theory structured and standardized. This will be his real job and the foundation of his skills.

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Verbalizing, breaking down and defining empirical expertise

To keep pace with new developments in both technology and organizational and management methods, management increasingly expects shop-floor workers to be able to verbalize and where possible define the components of the practical expertise they use in their work, as this will help with the incorporation of their expertise into control software. In the same way, management expects its employees to know more about the theoretical side of their work, so that they can acquire a better grasp of how systems function and continually improve their production effectiveness. Operators as a whole are expected to do less routine work but to step in more often to deal with non-routine situations; they are expected to progress from the lower to the higher cognitive processes, handling complex, multi-dimensional and less clearly defined information.

This being the outlook for the future, it is apparent that the debate as to the relative merits of a general education and technological knowledge as a basis for vocational

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training is meaningless. Technological knowledge is an essential foundation for vocational skills and for using the systems that already exist and are under development. A general education is no less vital in that it enables people to verbalize, break down and define their technical skills and 'see the point' of the work they do. An effective combination of general and technological knowledge is a prerequisite for the acquisition of a sound basic education. There are obvious immediate steps if we are to ensure that a sizeable proportion of the working population today and tomorrow is not excluded from acquiring the basic skills that will be demanded.

Organizational decisions and their effects on jobs

Traditionally the breakdown of a firm has been by its main functions (production, sales, marketing, etc.), each one organized as a more or less autonomous department. Today there is a change in the way in which those functions are structured. More specifically, the dividing line now tends to be between production planning and commercial marketing on the one hand and, on the other, manufacturing and control or maintenance. There is also a dividing line between those functions as a whole and financial/social management. These developments are a response to the problems of competitiveness already mentioned.

Growing interconnections between functions call for a combination of abilities

The reason why production planning and commercial have come closer together is the development of what are known in French as 'gap-filling strategies': product differentiation and rapid product turnover, based on the ability to predict changing tastes on key markets and create the products that will satisfy those tastes at the lowest possible industrial cost. This calls for quick interaction between departments within a company, not only in routine matters but in defining their individual roles. There must be a good deal of overlapping of the knowledge of the people responsible for each department. There must also be close cooperation between designers and researchers, since it may well be possible for the design people to make direct use of the researchers' findings in planning product differentiation and changes. This type of interconnection also calls for both organizations and individuals to combine a variety of skills in basic research and production expertise.

Closer links between production and control are created if the twofold aim is to improve the quality of the finished product and cut production costs. Poor quality, as expressed in a high rejection rate and a greater need for quality control resources, costs dear in the long run, both in the factors of production that are directly consumed rather than sold and in the factors of production indirectly mobilized. The solution currently being developed is to incorporate quality controls as early in the production process as possible and at every stage thereafter. This requires a reliable automatic control system, with the operators accepting more responsibility and stepping in at each stage of the process where necessary.

The integration of management functions into every other department is due to the need to cut production costs.[11] The operating criterion is no longer expressed as a technological optimum but as a financial/technological optimum. The criterion applies both to product and system designers and to the managers of human/machine systems. This is why analytical tools such as value analysis are coming into more common use, as well as the simple tools widely used in quality circles such as the 'causal trees' and 'Pareto diagrams'.

With this shift in frontiers, new 'mixed profile interface' functions are replacing the traditional specializations, a situation that is gaining widespread recognition.[12]

Several approaches to the restructuring of jobs

There is greater uncertainty as to what are the optimum strategies in terms of the organization of production and the linking of production with maintenance and planning.[13] Starting from the current situation – where the compartmentalized division of labour is the prevailing model and where, at the same time, integrated computerized control is being introduced – how should basic activities be aggregated and basic jobs then restructured?

One approach would be to aggregate jobs horizontally along a production line. Several steps in this line could be grouped together to form a single stage. For example, there could be three such stages: pre-processing, processing and post-processing (combined with packaging). The advantage of this method of restructuring would be to engender a feeling of responsibility among workers for their production line and therefore for the goods they produce.

A second approach would be the cross-aggregation of jobs on two or more production lines, with responsibilities being broken down into phases of stages, depending on the workplace. This solution has the advantage of creating greater uniformity of tasks and skills.

A third approach is to group external services such as maintenance, quality control or planning. The links between these and production are becoming ever closer because of the new market constraints and the need to make optimum use of systems. This is particularly true of maintenance, since the quality of maintenance affects the percentage use of systems and the evenness of production workers' workloads. Start-ups and shutdowns always create an extra workload by comparison with normal operation, as well as production losses. If the third approach is adopted, production workers would take over certain aspects of maintenance as part of their normal work. They would thus perform a more active role in the detection of breakdowns and in routine maintenance work,[14] giving them a greater sense of responsibility for their machines and reducing the rate of wear and damage.

All three approaches have their advantages and disadvantages, and the choice will depend on the practical circumstances, the main problems to be solved, the skills available and workplace configuration. Given the constraints in matching people to their jobs, each one will entail what are bound to be major organizational decisions.

■ The shift away from individual jobs and towards teamwork

There is even greater uncertainty as to whether the practice of matching one man to one job will continue or disappear. As integrated production systems become more fluid there is a growing tendency to entrust full responsibility for a substantial part of the production process to a team of workers. The team is led by a foreman, but there are no distinctions between its members in the jobs they do, their skills or their trades. The idea is that a team is semi-autonomous and self-renewing. Each team, therefore, is homogeneous, organizes itself and has multiple skills in that portion of the process for which it is responsible.[15]

The approach goes against the grain of French tradition, but it looks very promising provided that it is properly supervised. Labour costs are likely to be high because the job classification of every member of a work unit must be high. Training will also be costly, as money will have to be spent on giving every worker the level of skills for his grade. On the other hand, it promotes great operational flexibility and adds to the ability to cope with technical and social contingencies, since members of a unit are interchangeable. It also provides scope for a more flexible adjustment of the volume and nature of the work provided. Through 'learning by doing', members of a team can cope with additional workloads when a process is being started up and stabilized, and the time they start to save thereafter can be reinvested. It can be put to use elsewhere without the reduction in the size of the workforce disrupting the production process. Alternatively the terms of reference of that workforce can be broadened, and the extra time devoted to thinking how to improve the machines. If this approach is taken, it is easier to deal with reductions or changes in the work or the number of teams.

Provided that this approach is properly managed in terms of the team's experience and relations with the hierarchy, a group of people will be formed who are not only competent to do a given job at a given time but are capable of training themselves and others. Working together, they will be able to manufacture products, generate their own skills and pass on those skills to newcomers. It will also reduce the cost of formal training and retraining, while increasing direct production efficiency.

Last, though perhaps not least, the advantage of this approach is that it alleviates the constraints that the architecture of a computerized control system may impose on the organization of labour and the role of each individual.

The ways in which outside social references are reflected in job classifications and the training required

■ Workplace structures in relation to macro-social structures

The division of labour, the organization of work and the effects on jobs or tasks will depend on employers' decisions as to technology and models of organization and management. Employers' actions or intentions as regards future developments are, however, swayed by two factors which are sometimes underrated and sometimes over-estimated. The first is the internal structure of each workplace, which acts as a brake on any evolution not in line with its past development. The present is a strong constraint, often making it hard to contemplate a future that represents too abrupt a departure and makes too great a demand in terms of change and conflict. The second factor is society and its structures, the framework of reference for people within the workplace which to an extent determines their scope for manœuvre or the ways they will act.

These two opposite factors interact and, depending on the circumstances, each one influences or is influenced by the other, sometimes both at once. In combination they serve as benchmarks for the people involved and even create standards.

The significance they confer on the division of labour is not just technical but social as well – status, pay, requirements governing access to jobs and the prospect of joining certain social groups. This explains the differences observed in the structuring of labour from country to country.[16]

On the macro-social level, status, pay and prospects are embodied in rules and procedures laid down by law and negotiated agreement. What form they take in practice, however, depends on the way people within the workplace interpret the law and agreement. For example, companies may be subject to the same collective labour agreement, operate on exactly the same markets, manufacture similar products by comparable methods and be similar in size but still differ considerably in their pay structure, technical organization, production management, the way they regulate labour relations and how they handle tensions among the people concerned, depending on what have been analysed as typical patterns.[17]

■ Scope for widely differing choices on the acquisition of skills: the example of machine programming

Because of this interplay between macro-social norms and the norms inherent in each workplace, the question of building up the skills that will be needed in the medium-term future is an open-ended question and a challenge.

This is very evident in France in the matter of machine programming. The questions are how to allocate the task among different departments (production, maintenance and methods) and among job categories (shop-floor workers, foremen and engineers), and what is required of someone before he is capable of programming (should he first have had the kind of advanced technological training acquired in a course leading to the Baccalauréat de technicien supérieur [higher technician's diploma] or at an Institut universitaire de technologie [university faculty of technology]?). In some cases, this would be a fairly sharp break with tradition.[18]

For example, if the task of production planning is assigned to engineers from the methods department and if the skill is acquired through shop-floor experience plus a slightly higher level of initial training and further in-service training, the equilibrium does not really change, it just evolves. This is not the case if the skill is acquired by direct recourse to young technicians with a higher level of training. In this case, the methods department not only preserves but reinforces its lead, and shop-floor workers lose the opportunity of promotion via the channel carrying the greatest prestige. The equilibrium is severely disrupted.

The equilibrium is also disrupted, although in a different way, if programming is performed within the production department. The effects on the balance of power will depend on whether programming is assigned to supervisors or to shop-floor workers. If it is assigned to the latter, they will move up to a higher grade in the register of factory jobs, as permitted by the revised collective labour agreements for the engineering industry (UIMM). If the task is assigned to supervisory personnel, their role and status by comparison with the methods department are enhanced and they regain some of the technical prestige they were tending to lose; at the same time, access to skills via shop-floor experience and continuing training would once again make their jobs attractive as a potential channel for promotion for the shop-floor worker. If, on the other hand, programming is made the responsibility of shop-floor workers, and if their job classification is then upgraded and brought in line with that of their supervisors, the position of the latter is weakened: supervisors will lose their edge over those subordinates who have acquired higher status and a skill the supervisors lack. The result would be an even greater disruption of the traditional balance of power in French factories.

Another alternative is to assign programming to the methods department, raise the level of recruitement of workers to those, for example, holding the Baccalauréat de technicien supérieur, and then promote them to supervisory and methods posts. It involves creating a new level of shop-floor skills which is in keeping with the French tradition but is out of step with the educational system. It also creates a hiatus further down, as regards access to skilled labour jobs.

Conclusion: a future determined by the forces of society

We hope that the examples we have given illustrate the need for a painstaking analysis of the many and varied factors involved in attempting to plan the structure of jobs in the future and map out the training needed as a result. The factories of the future will certainly be very different from the factories of today due to the combined effects of decisions as to technologies, models of organization and management procedures. The people who work in these new factories will not be expected to have the same expertise as today's workers, nor will work practices there be the same. Research conducted in workplaces in European Community Member States over the past few years gives a reasonably clear picture of major trends in the future.

We do not have such a clear picture of the nature of work itself and all it implies; pay, status, conditions of access and the social prospects it affords. The factories of the future and the training their workforce needs must still to a great extent be planned in the light of whatever is seen as the macro-social scenario. Will that scenario be one of continuity or a break with the past? Will the patterns of the past be retained and elements introduced that are new and different but reflect what has gone before? The answers to these questions will depend on the interplay of all the people involved in society in the countries of the European Community.

Notes

[1] This model is minutely described by J. BULLINGER, J. WARNECKE and P. LENTES, 'IAO Stuttgart: towards the factory of the future', paper read at the Symposium on 'New production system: the implication for work and training in the factory of the future', Turin, 2 to 4 July 1986, 26 pp.

[2] J. FIX-STERZ, G. LAY and R. SCHULTZ-WILD, ISI Karlsruhe ISF Munich, 'The present state and development tendencies of FMS and FMC in the Federal Republic of Germany', Turin Symposium, 2 to 4 July 1986, 22 pp.

[3] M. HOLLARD and G. MARGIRIER, 'Nouveaux procès de production et implications macro économiques: contribution au débat sur la flexibilité', in *Revue Formation-Emploi*, No 14, April/June 1986, pp. 22–34.

[4] This 'anti-model' is clearly described in P. KRISTENSEN, IEP, Roskilde University, 'Technological projects and organizational changes: the dissolution of strategies and structures in Danish firms working towards flexible specialization', Turin Symposium, 2 to 4 July 1986, 57 pp.

[5] A d'IRIBARNE, 'PME, innovations technologiques et compétitivité économique', in *Revue d'Economie Industrielle*, No 38, 1986, 11 pp. A. d'IRIBARNE, 'L'ordinateur, l'usine, la culture et les emplois', in *Projet*, No 201, op. cit.

[6] A. SORGE, 'Polarization of skills in the future?', in CEDEFOP, *Vocational Training*, No 11, June 1983, pp. 22–25.

[7] See B. W. HAYWOOD, DBM Brighton Polytechnic, 'Organizational aspects of FMS in the United Kingdom', Turin Symposium, 2 to 4 July 1986, 14 pp. M. DODGSON, TTC, London, 'Small firms' investment in, and use of, CNC machine tools: lessons for flexible use', Turin Symposium, 2 to 4 July 1986, 10 pp. R. H. BILDERBECK, TNO APELDOORN, 'Work and training implications of programmable automated systems', Turin Symposium, 2 to 4 July 1986, 15 pp. M. ROSANVALLON, IREP Grenoble, 'Flexible manufacturing systems and work organization', Turin Symposium, 2 to 4 July 1986, 23 pp. See also FIX-STERZ *et al.* (op. cit.) and Kristensen *(op. cit.)*.

[8] A. d'IRIBARNE, 'La nécessité d'une éducation professionnelle', in *Revue Formation-Professionnelle*, No 11, June 1983, pp. 15–19. L. TANGUY, 'La question de la culture technique à l'école', in *Revue Formation-Emploi*, No 13, January/March 1986, pp. 35–44.

[9] 'Artificial intelligence is that branch of information and computer technology that is concerned with the computer taking over intellectual tasks where it is not known how humans can perform them. . . . Expert systems . . . make it possible to tackle the computerization of certain skilled intellectual functions . . . that are often difficult to codify in reliable and definitive algorithmic form.' These are functions like 'identifying or diagnosing a situation and predicting events'. H. H. FARRENY, 'Les systèmes experts, principes et exemples', CEPADUES, 1985, p. 7.

[10] E. ZUSCOVITCH, 'Une approche micro-économique du progrès technique. Diffusion de l'innovation et apprentissage industriel', doctoral thesis in economics, Université Louis Pasteur, Faculté des Sciences Economiques et de Gestion, Strasbourg, 1984, mimeographed copy, 450 pp.

[11] P. ZARIFIAN, 'Le développement de la dimension gestionnaire de la qualification. Portée et contradiction', in *Recherche Economique et Sociale, op. cit.*, pp. 115–148.

[12] 'Nouvelles technologies dans l'industrie. L'enjeu de la qualification', in *Sociologie du Travail*, No 4, October/December 1984.

[13] A. d'IRIBARNE and B. LUTZ, 'Work organization in flexible manufacturing systems. First finding from international comparison', in *Design of Work in Automated Manufacturing Systems*, edited by T. MARTIN, published for International Federation of Automatic Control by Pergamon Press, Oxford, 1984.

[14] J. D. DURAND, J. DURAND-DEBAS, J. LOJKINE and C. MAHIEU, 'L'enjeu informatique: former pour changer l'entreprise', Meridien Klincksieck, *Collection Réponses Sociologiques*, Paris, 1986, 192 pp.

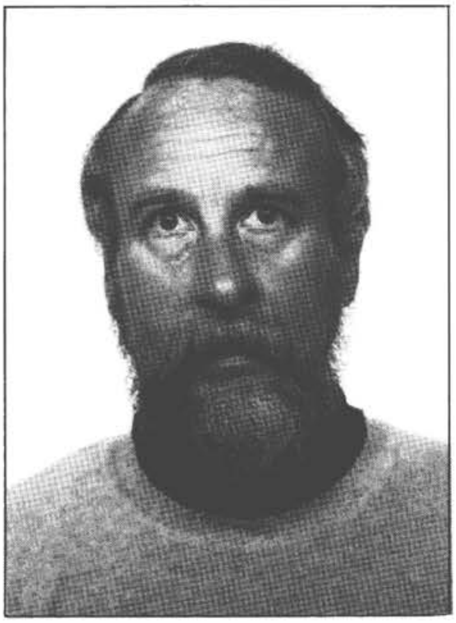
[15] On the concept of the production cell in which each person takes part according to his skills, see A. COFINNEAU and J. P. SARRAZ, 'Impact social et organisationnel des automatismes et de la robotique – Peugeot Mulhouse', *IECE Dévéloppement*, published by the Programme Mobilisateur Technologie Emploi Travail, Ministère de la Recherche et de l'Enseignement Supérieur, October 1985, 208 pp.

[16] A. d'IRIBARNE and J. J. SILVESTRE, 'The training of workers and the competitiveness of firms: the search for a solution to the crisis', in D. L. PARKES, B. SELLIS and M. TESSARING (editors), *'Education, Training and Labour Market Policy'*, The Hague, 1986.

[17] D. EUSTACHE, 'Structures des salaires et organisation du travail. Le cas des industries chimiques en France', thesis on economics and the sociology of work, University of Aix-Marseilles II, Faculty of Economic Science, LEST/CNRS, Aix-en-Provence, 1986, mimeographed copy, 600 pp.

[18] M. MAURICE, F. EYRAUD, A. d'IRIBARNE, F. RYCHENER, 'Des entreprises en mutation dans la crise. Apprentissage des technologies flexibles et émergence de nouveaux acteurs', LEST/CNRS, Aix-en-Provence, mimeographed copy, June 1986, 440 pp.

[19] M. CARRIÈRE-RAMANDELIA, PH. ZARIFIAN, 'Le technicien d'atelier dans la classification de la métallurgie', in *Revue Formation-Emploi*, No 9, January-March 1985, pp. 11–24.



The future of work*

Working society – dying or in crisis?

Walter R. Heinz

In the debate among social scientists and politicians 'working society' has been the subject of some controversy for several years. In his book on structural problems in working society and its future prospects (1984) Claus Offe argues that its future is no longer guaranteed since gainful activity is waning in importance structurally and in the minds of the public. He qualifies this bold claim, however, by distinguishing between two types of work, production work and service work. Production work is primarily an activity that is standardized technically and in terms of time spans while service work is used to plan and organize production and market processes. 'Reflexive rationality', according to Offe, is one of the main features of service work; it leads to a type of occupational socialization that is characterized by detachment from externally determined and bureaucratic structures. This detachment is associated with an attitude which is critical of the values traditionally placed on work and consumption and favours human standards.

People are increasingly considering more than the mere necessities as they plan their lives: work is no longer the sphere to which all other aspects of life are related. In short, it has become peripheral.

This is due, Offe claims, both to the gradual secularization of the Protestant work ethic and to the impairment of this ethic by alienated working conditions and the content of work, which prevent the worker from identifying with what he does.

As further evidence of the erosion of working society Offe maintains that interruptions and stresses in working careers and not least the diminishing proportion of life spent at work are resulting in work becoming a secondary consideration, and its function as a guide in the development of identity is therefore weakening. Today man cannot be motivated to work either by income incentives or the danger of losing income because the costs – i. e. the stresses imposed by work – correspond less and less to the subjective benefits.

Another line of argument advanced by Offe is the proposition popular in conservative circles that the risk of losing jobs and incomes no longer has a motivating or disciplining effect because the collective security system makes it appear rational to employees to take advantage of the welfare state.

Nor, in Offe's opinion, is mass unemployment 'stimulating the individual's motivation to earn', which he refers to as a 'control paradoxy of the labour market', but 'evidently causing those affected to retreat fatalistically or to engage in collective self-interpretations in which the government's economic, labour market and social policies are blamed for the emergence of such marginalized and unprivileged beneficiaries of the social security system' (1984, pp. 34 – 35). Despite the consistency of these propositions, which indicate the end of working society, they conflict with most studies that have been made of the attitude of young people towards training and work and on the contraints and consequences which unemployment entails for the long-term unemployed.

Another proposition, which takes the subject here under discussion further, is put forward by Ulrich Beck (1984). He assumes that our society is advancing towards a cultural evolution of work heralded by the growing fragility of 'the belief in progress that acts as a stabilizing force for the future'. While acceptance of our society's technical and economic progress made for standard-setting cultural stability until well into the 1960s, which was also reflected in the fact that the work ethic went virtually unquestioned and in the identity of paid work and self-concepts, a tendency for the 'status- and consumption-oriented system of values' to disintegrate has been apparent since the 1970s.

Beck refers to this highly momentous tendency, which has also led to changes in socialization processes and moral concepts, as the 'individualization' of the situation and careers of people who are being released from the traditional ties of their original environment by mobility, education, com-

* This article is based on a paper presented by the author at the University of Essen during the 'Vocational Training 1986' conference.

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petition and their relationship with the market and 'left to their individual fate in the labour market' (1984, p. 55), with all the risks and opportunities this entails. The criticism of progress coincides with post-materialistic attitudes and alternative life styles characterized by the quest for self-fulfilment and awareness of the ecological and interpersonal costs of technological and economic progress.

However, Beck makes an important qualification here: this tendency to reassess criteria of success and goals in life is confined to younger, educationally and financially privileged social groups, the less well educated, older and economically more poorly placed sections of the population remaining attached to the traditional system of values and its symbols of occupational success.

Despite this contrasting of representatives of the old and new systems of values, Beck makes it clear that the relationship between moral concepts, material reproduction and attitudes towards work is more complicated than assumed by the supporters of the proposition that working society is coming to an end: he refers to a convergence of the old and new systems of values where gainful activity is concerned. To support this contention, he argues that a particular feature of the individualized social character is that he takes up all the options for self-realization, including gainful activity as the basis of economic security.

'Individualization thus increases the individual's dependence on paid labour . . .,' all the more so at a time of mass unemployment, which coincides 'with culturally induced growth of demand for (meaningful) jobs within a single generation' (1984, p. 58).

The younger generation's insistence on work and working conditions that enable them to act on their own responsibility and initiative, it seems to me, matches the predictions by social scientists of the development of industrial and service work. All that is really lacking, therefore, is the realization on the part of employers and managers that they should take advantage of the trend towards cultural evolution as technological and organizational innovations are introduced into firms.

The recent history of collective bargaining on the 35-hour week in the metal industry in the Federal Republic of Germany and the 1985 Employment Promotion Act reveal, however, that employers and the political representatives of their interests have so far balked at drawing this conclusion.

In addition, the current thinking behind rationalization is inconsistent with a comprehensive qualitative change in all jobs. This is clear from the future scenarios of gainful acitvity presented by Kern and Schumann and by Baethge and Oberbeck: only a minority of employees have access to the qualification profiles of the new production worker and the skilled salary-earner.

The first provisional conclusion to be drawn, then, is that the end of working society is a myth extrapolated abruptly and therefore mechanistically from surveys of changes in values and the obvious ecological and labour market trouble spots in society. Ironically, this oracle is also nourished by usually conservative social diagnosticians and pollsters, who rebuke the youth for abandoning achievement in favour of goals that conflict with the established system. A change of attitude to life and a wider variety of identity-generating factors are undoubtedly to be observed, but not conversion from work to non-work. Qualified young people in particular have replaced the traditional principle of 'living to work' with the idea of 'working to live'. That this is not flight from the world of work is demonstrated by empirical studies conducted in the last five years: although work is not seen subjectively as something peripheral, the attitude of young people towards work has become more ambivalent and inconsistent.

Future scenarios of gainful activity: (Re)qualification as labour market risks grow

In the debate among social scientists triggered by the American social theoretician Braverman (1977) the social scandal of mass unemployment and the gloomy future of work are usually ascribed to de-skilling and labour-saving rationalization in accordance with the principles of Taylorism. This attempted explanation is, however, shown to be unsound by current scenarios of the future development of production and service work: the various forms of rationalization are in fact part of a work and personnel policy geared to flexibility and adopted by management and employers' associations whose long-term profit calculation is closely linked to the potential for and limits to the continuing training of the workforce.

The aim is to devise new strategies for translating economic targets into corporate action or, in the terminology of Horst Kern and Michael Schumann, 'new production concepts'. In their forward-looking study 'The End of the Division of Labour?' (1984) they consider the dominant forms of rationalization in the car, machine tool and chemical industries in the early 1980s. They assume that the general introduction of technology will create more problems than it solves and that, given advanced production methods, it is more efficient to utilize the skills of the workforce than to split work into individual activities à la Taylor. Consequently, they forecast the reprofessionalization of occupationally organized work in the machine tool industry (the industrial mechanic), of production work in the car industry (the systems minder) and of skilled work in the chemical industry (integration of production and maintenance tasks). The demand will then be for workers whose occupational socialization has given them skills which ensure that, in view of the high cost of equipment and the product flexibility expected by the market, interruptions to production runs are kept to a minimum. And this will be possible only if workers have a better knowledge of the production process and more responsibility.

Particularly important for the working future of young people is Kern's and Schumann's reference in this context to the employer's 'modernized' image of the worker, whose intellectual abilities and interest in qualifications should be harmonized with the interests of the company by non-authoritarian means. The appropriately qualified new entrant should therefore be given the scope to use and develop his skills.

However, Kern and Schumann also realize that the type of rationalization they refer to as 'new production concepts' has highly problematical implications: it will encourage the consolidation of divisions that have already occurred in society and especially the separation of the employed from the unemployed and new entrants to the labour market, whose chances of integration will dwindle where rationalization follows the line of the new production concepts.

It is becoming increasingly difficult for the beginner to overcome the more stringent selection processes now associated with absorption into and membership of the core workforce of large firms. Despite the new production concepts, Taylorism is not completely obsolete, it is still the rule in fragmented and inflexible unskilled work, and it is what awaits those young people who do not succeed in penetrating the core workforce. This also means – as the complaints about the shortage of skilled workers show – that education and training are regarded as preconditions to be satisfied by jobseekers. They must be of 'Olympic standard' as they join the firm, even though the necessary practice facilities and sports arenas, i.e. initial and continuing training courses, are not available.

Even more decisive than the change in qualification requirements for the future of working society are shifts in the structure of employment towards the service occupations in which salary-earners and civil servants are predominantly employed. Martin Baethge and Herbert Oberbeck (1986) see this trend as a symptom of a radical transformation of the social structure, leading to a qualitative reshaping of the relationship between industry, society and culture. They point out that, as a result of information and communication technologies, a period of selective rationalization of simple office work accompanied by a strengthening of the specialized dimension of the activities of skilled clerical staff is now being followed by what is above all systems-oriented rationalization, taking in the sequence of

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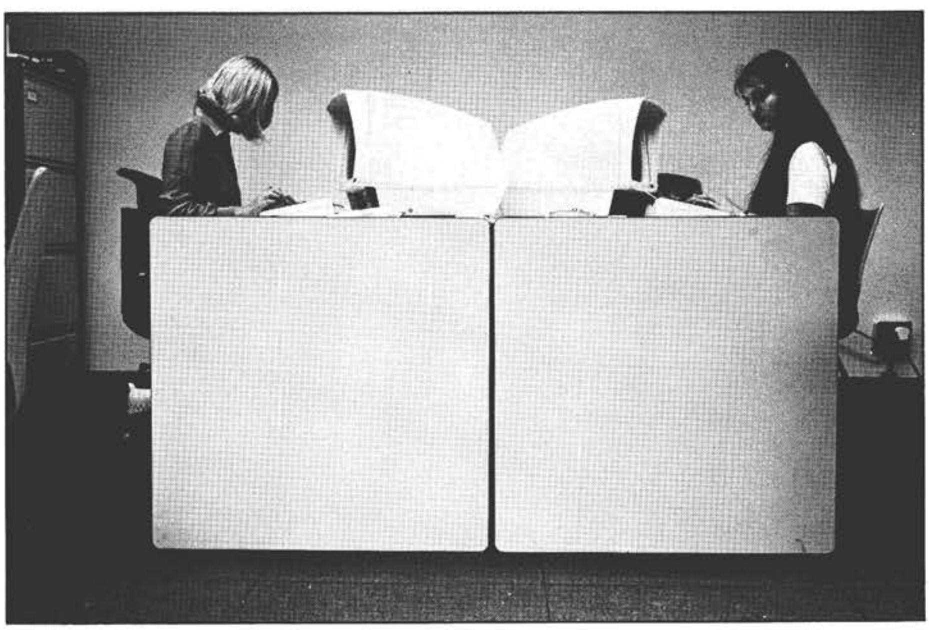

Mike Abrahams/NETWORK

operations and the central control of various functional areas in both production and administration.

The introduction of the computer into the office has so far principally resulted in a deterioration of the working conditions and the growing risk of redundancy of low-grade office staff – mostly women – and staff handling routine matters, and opportunities for intercompany networking offer considerable scope for further rationalization to the employee's disadvantage, leading Baethge and Oberbeck to infer major redundancies in the next few years. Worsening working conditions and job losses are already affecting simple, routine activities (typing, invoicing and book-keeping), which are being further fragmented and so de-skilled. In commercial and coordinating activities a trend in the opposite direction can be predicted since the relationship with the market and the customer make more holistic work processes economically more efficient for the firm. It is even likely that, as decentralized data processing spreads, low-grade and specialized clerical activities will again be combined to form a service package geared to the customer. The expansion of the range of tasks to be performed may initiate a reclassification of specialized work, and this will result in a change in the working habits of the skilled salary-earner: integration into a system of communication and supervision through the medium of electronic data processing will call for more general intellectual skills – abstractive capacity, willingness to concentrate, accuracy, speed of reaction and adaptability – to the detriment of specialized occupational know-how acquired and occupational experience gained over the years.

If we compare this trend in the service sector with the new production concepts in the industrial sector, a growing approximation of working conditions and qualification requirements in the two sectors can be detected. According to Baethge and Oberbeck (1986), however, requalification is confronted with a trend towards the 're-feudalization of employment relationships and of the labour market'. By this they mean that, as the number of jobs in the service sector declines, so too are the opportunities for qualified salary-earners to achieve professional advancement by changing firms. Like production workers, they are dependent, for better or worse, on their present employer. By making provision for continuing training, he ensures that his employees can adjust to the new technologies and, by 'looking after his staff', he holds on to those employees in whose initial and continuing training he has invested. Direct control by technology gives way to stronger ties to the firm in the case of specialized tasks, through continuing training and the delegation of responsibility, for example. Participation in in-company continuing training, however, is selective: poorly qualified employees and women in particular are largely excluded. For these categories of employees job-related training or instruction in new work routines is still the rule.

There is thus considerable pressure on employees' representatives in the firm and the trade unions generally to take action.

Change of moral concepts or secularization of attitudes to work?

Is the crisis in the labour market and the de-skilling of work in many jobs in industry and the service sector now being accompanied by an erosion of the very traditional concepts of achievement and career, as Offe (1984) assumes? Or will the persistent shortage of training places and jobs result in a revival of the positive attitude to work, as a consequence of the socializing effects of the search for work, vocational training and corporate labour market strategies? Or will nothing change until the social and political nature of paid labour changes fundamentally – until the labour market, as the eye of the needle for gainful activity, obeys only the efficiency criteria and profit interests of the employers? (See Heinz, 1985a)

To answer these basic questions, it is first important to take seriously the statement by Bonss and Heinze (1984, p. 26) that an investigation into the consequences of the crisis must be tackled at two levels: 'as a problem connected with the structural crisis in the labour market and as a question of the subjective value attached to gainful activity.' The first level concerns the decline in the number of paid jobs, the second, on the other hand, the crisis in the attitudes of various sections of the population and age groups to work and the scale of this crisis. As I have said above, it would be rash to assume that the social and subjective importance of work is waning.

What do we know about the direction and scale of the changes in the subjective value attached to paid work and the actions young people consequently take? (See Heinz, 1985b.) Here we are initially dependent on a small number of surveys which have produced statements on attitudes to work at different times in the past.

A workshop report (Fuchs and Zinnecker, 1985) based on a current study in which surveys of young people (aged 15 to 25) in the 1950s are compared with similar surveys in the 1980s reveals little change in the attitudes to work of young workers as a whole (even over the age of 30). Fuchs and Zinnecker rightly point out, however, that the limited tendency for change in the overall samples does not mean that there has not been a change in attitude in subgroups in the intervening period. For example, they detect significant differences in attitudes to work as between the sexes: young working women in the 1950s and 1980s hardly differ, their attitudes positive in both cases, whereas young men have clearly come to take a more detached view of work.

Allerbeck and Hoag (1985) similarly find little evidence of a 'renunciation of working society'. Their comparison of young people in 1962 and 1983 shows that less importance is now attached to work, 'but the decline is not so pronounced as to justify the contention that attitudes to work have changed dramatically' (p. 70).

The desolate situation in the labour market, however, had caused few of the young people questioned in 1983 to make major changes in their plans for their working lives. They were fully aware of the difficultes in the labour market. Those who managed to find a training place were fairly satisfied with their training in 1983, as their counterparts had been in 1962. Asked if they would choose the same occupation again, the proportion answering 'yes' was only slightly smaller in 1983 than in 1962. However, the fear of not being taken on after training was quite obviously widespread in 1983. The fear of not finding employment was more pronounced among young women than among young men. This is due to their objective situation: girls are subject to the mechanisms of a labour market that is segmented according to sex, and if they find a job at all, it is likely to be in a small or medium-sized firm and limited to a narrow range of occupations.

The changes of attitude to work among girls and young women are worth noting. In the last 30 years there has been a significant shift in their thinking from family to work, which is also accelerating the change of self-definition in the role played in women, a factor that is similarly reflected in the general rise in the level of school-leaving certificates obtained by young women (see also CEDEFOP, 1980).

As an extension of the comparative cross-section studies of changing attitudes among young people, it can be deduced from the qualitative case studies discussed below that, while young people are deciding what they want to be after leaving school, their plans and attitudes change depending on how they view the situation in the training place market and the prospects of finding permanent employment. But let us first consider the changes and shifts in the practical experience of work. Baethge *et al.* (1983) have compiled figures on the trend in the gainful activity of various age groups which reveal a significant decline in the employment rate among 15- to 20-year-olds between 1970 and 1980. This was due to the growing numbers of young people under 20 staying on at school, preventing them from becoming economically independent. The delayed entrance of young people into the labour market results in a different range of experience: 'a shift in the experience of young people in this age group away from a way of life which is in most respects integrated into and related to work to one that is largely determined by education' (p. 221). Attitudes to work and standards of achievement will therefore carry less weight in this age group than among young people of the 1950s and 1960s. However, the critical and emancipatory potential thus released continues to be closely linked to family and educational socialization and, as Baethge *et al.* (1983) rightly stress, is qualified by the crisis in the training place and labour markets. Consequently, the question which also arises for these authors is whether young people are again focusing on standards of work and achievement or making a self-confident appraisal of what they expect of work, or whether something between the two is happening. There is no denying that the delinking of vocational training and employment is being accompanied by 'destabilization' of the transition of young people to working life. From this Baethge *et al.* (1983, p. 235) infer a 'reduction of the identity-generating potency of work, which is both due to structural factors in the system (the tendency for occupational structures to disintegrate) and is intensified by the crisis.'

Varying this proposition slightly, I assume that a vacuum in respect of attitudes to work and standards of corporate behaviour is filled by standards set by the labour market or employment prospects. In our qualitative longitudinal study of the transition from school to the labour market (Heinz, Krüger *et al.*, 1985) we found, for example, that, in gradually aligning their occupational options with the impending requirements of the labour market, young people apply, as it were, a normative logic. This 'option logic' is, so to speak, already prescribed by the opportunities presented by different types of school, updated during the practical business of choosing an occupation and comes to a temporary end during the subjective assimilation of the outcome of this choice. In this process it is clear that young people apply conventional interpretation models under the changing conditions governing attitudes to occupations and actions related to the labour market in their attempts to forge a subjective link between the needs of society and their individual interests.

Wolfgang Willems/DTU GmbH

Although well aware of the risks and under no illusions, the lower-grade secondary school pupils we questioned had not yet excluded vocational training followed by work in the occupation concerned from their future prospects. In fact, they placed particular emphasis on their own responsibility for the implementation of their plans. Their efforts to compensate for the structural change in the labour market by redefining and rejecting interests in given areas of work illustrate the considerable pressure on them to adjust exerted by the social circumstances in which future prospects are increasingly determined by the restrictions imposed by the social reality of the labour market.

Even before young people enter the world of work, the crisis in the training and employment system results in interests in reproduction and security criteria playing a dominant role. This trend is subjectively reflected in an ambivalent attitude towards the action that should be taken: on the one hand, income and advancement are becoming less important aspects of work than its content; on the other, expectations as regards self-realization through work are seldom expressed aggressively, nor is every opportunity for training and employment seized, a criticism that also extends to alternative or non-conventional local employment initiatives.

There would appear to be sufficient evidence that the individualization of the change of status with the transition to the world of work tends to result in an ambivalent attitude to work rather than its erosion. To my mind, this is because the discrepancies between the areas of socialization and the training or earning situation of young people create major attitudinal pro-

blems for large sections of the younger generation as the pressure to act increases. Consequently, demands in respect of personal self-realization through work and of social independence are subordinated to reproduction interests. Experience in the family and at school, in vocational training and in government-sponsored training or employment schemes, during the search for jobs and in actual employment is determined to a decreasing degree by social origin, sex or school career and increasingly by regional supply structures, the accessibility of occupations, sectors and the size of firms. The responsibility placed on young people for coping with processes of structural change in working society, through participation in bridging schemes, for example, delays practical work experience for most young people until they are over 20 and, even before they make the transition to employment, increases their awareness of a potential crisis situation.

Young people are thus subjected to considerable pressure to acquire qualifications, generated less by a renewed yearning for education than by labour market constraints. This does not weaken the principle of individual willingness to achieve but, paradoxically, tends to strengthen it in the minds of young people and in their efforts to consolidate their identity in the face of limited opportunities. The achievement principle, however, applies only in a broken and, as it were, defensive form. Young people are forced to develop a down-to-earth attitude to work, from which they can also develop the ability to take a detached and critical view of the conditions governing action in the firm and to stand aloof from the success and career ideologies, which contrast starkly with practical experience in the labour market.

The initial question concerning the subjective effects of the crisis in working society can now be answered. The structural discontinuities in the employment system have caused awareness of the risks involved and the ambivalence of the attitudes of young people to work to come to a head: even if work develops as a low-skilled or undemanding activity – sometimes reduced to casual labour – its importance for the identity of the individual is not denied. At most, it is considered subjectively less significant, but socially and, above all, economically unavoidable. The unthinking acceptance of paid employment as it is which is typical of much of the older generation is thus no longer common among young people. At socio-psychological level, then, young people are showing signs of an increasingly ambivalent attitude to work, in which the structural inconsistencies between training and the use of labour, between training efforts and more stringent selection in the labour market are not clearly reflected in instrumental or substantive attitudes to work. For most young people paid employment continues to be a means of achieving social and material independence and recognition of productive activities independent of the family. On the other hand, they are well aware of the stresses and risks inherent in paid employment. Both tendencies are apparent in the attitude to work that continues to dominate. But only those young people who become part of the core workforce, especially of large firms, with the chance of in-company continuing training will succeed in finding jobs that interest them.

Unless there is a fundamental redistribution of work, the importance of the content of work will wane in the future for the vast majority of the unemployed and of school-leavers and job-seekers threatened by de-skilling and unemployment, and job security or the demand for basic material safeguards will become more dominant.

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Photobous Leopin

The human element in tomorrow's factory

W. McDerment

There has probably been more science-fiction type writing and discussion on the factory of the future than on almost any other subject in recent times. Many of the discussions appear to assume that there will be a uniform progress towards what is loosely called the factory of the future, with the so-called unmanned factory being the goal of many research and development specialists. The unmanned factory is, of course, a nonsense concept, but there is no doubt that highly automated, computer-integrated manufacturing techniques will enable many factories to operate with a very low level of manning.

The factory of the future will, except in a very few cases, be built on the manufacturing complexes in operation today; it is important to remember this, and to see progress towards the factory of the future as part of a continuum of industrialization. There will be instances of so-called 'green field starts' where new factories will be built, incorporating the latest integrated automated manufacturing facilities from the first day; some such factories already exist, but they are very much the exception.

This means that the so-called factory of the future will, in most cases, be created in incremental stages by people who will need to become increasingly upgraded in their educational and professional qualifications to cope with the complexity of such systems.

W. McDerment
Project coordinator in CEDEFOP

The more sophisticated the new technologies become, the fewer people who will be needed to programme and supervise the manufacturing processes, and the trend to decreasing numbers employed in manufacturing industry is likely to continue.

Much has been written about the unmanned factory of the future, and many references made to the FANUC factory at Mount Fuji in Japan, which has been described by western engineers as the nearest thing to an unmanned factory. To see the operation of this production unit, which runs all night with only one man in a control office, gives a chilling idea of the potential of automation.

The pace of technological change

One of the major problems facing industry today is the increasingly rapid pace of technological change, leaving slow-changing firms vulnerable in domestic and overseas markets. Inside the factories new technologies have transformed layout and production processes to such an extent that many former employees would hardly recognize their previous workplaces.

People employed in car manufacturing, for example, have seen a revolution in manufacturing processes, based on the latest technological developments, undreamed of 15 years ago. Indeed, most car plants have introduced highly automated, computer-programmed assembly lines only in the past 10 years.

A car factory employee who had left the company 10 years ago, after working on an assembly line with hundreds of colleagues, would probably be greatly surprised if he returned to his once familiar assembly shop and saw a highly automated assembly line today, with its automated guided vehicles delivering and collecting components from the flexible manufacturing cells.

Looking down the long assembly lines at the 100 or more robots, his first reaction would be to marvel at the mechanical precision of the robot teams; his next reaction would be to wonder where most of the assembly workers had disappeared to.

The geographical isolation of the remaining workforce would be a considerable surprise to him, and what would he think of the attempts to humanize the workplace a little, with the workers painting women's names on the robot control units' doors.

The modern, automated car assembly plant is a good starting point for a discussion on the pace of technological change, and the factory of the future.

When man first landed on the moon, 17 years ago, much of the new technology applied in automated, computer programmed production processes did not exist. Robots were at an elementary stage, and artificial vision in manufacturing and inspection work still a remote possibility. Today, robots carry out a range of tasks, albeit still limited, and artificial vision is being increasingly applied in manufacturing and inspection work, enabling 100% inspection rates on essential components, in, for example, brake linings for cars.

Developments in tactile and visual sensor equipment open up new fields of application for robots in situations where they have not previously been used.

In the field of artificial intelligence, despite slow progress and many setbacks, firms increasingly see expert/knowledge-based systems as the key to further integration of powerful computerized planning, manufacturing and administration systems all linked up in local or wide-area networks.

Satellite communication technology makes a geographical spread of administrative, manufacturing and sales functions possible and easy, whether between locations in one country or facilities based in different continents.

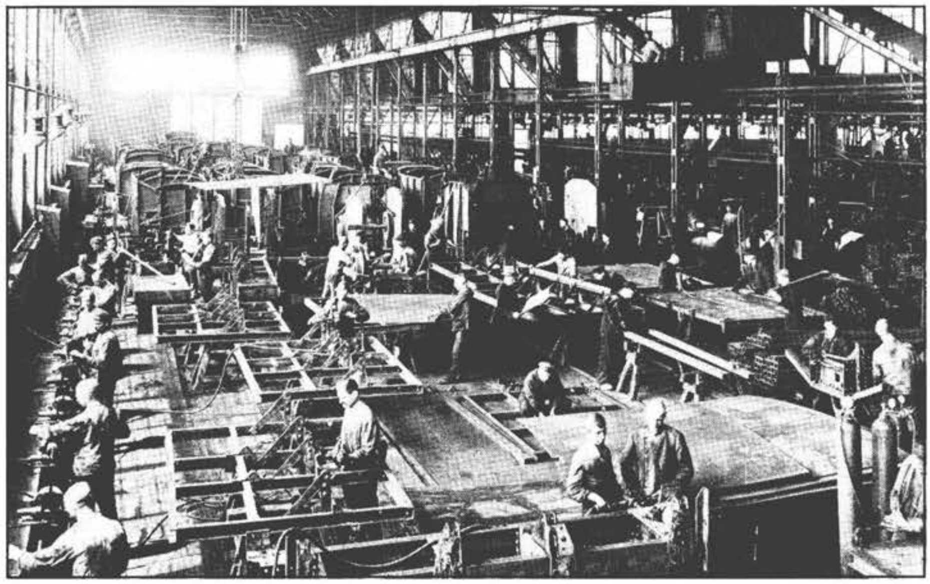
The potential of new technology requires us to think in much wider terms, outside our own, immediate, small world of the factory or office and our own task; it requires us to think in terms of systems and of accepting more responsibility for the planning and supervision of our work as part of the whole.

A good example of highly automated production systems can be seen in the various process industries such as oil and chemical manufacturing plants which are highly automated, computer-programmed and controlled and run with a minimum of human supervision. In many ways, the so-called factories of the future are going in the same direction, and will have many planning and control processes in common with the process industries. This similarity will become even more apparent as the various technologies develop over the next few years.

Already, this trend is having an influence on the training of technicians and maintenance personnel in some countries, where training syllabuses designed for technicians and maintenance personnel working in process industries are now being found to be suitable for the training of similar occupational categories in factories.

Planning for technological change

Advancing towards the factory of the future demands that technological change, as an on-going phenomenon, has to be mastered in all its ramifications to ensure a stable future for the enterprise.



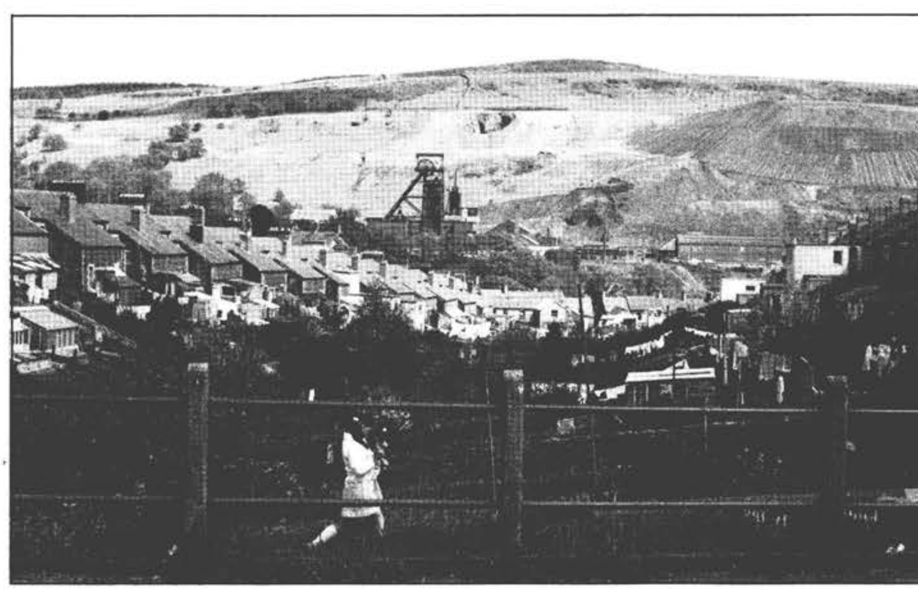
ULLSTEIN

Working long hours in physically exhausting conditions.

The role of long-range strategic planning assumes greater importance than ever in relation to technological change.

A key issue in the question of technological change is the importance of the short and the long-term perspectives, both at company and at national level. Meeting the short-term needs to work with new technologies in enterprises has many attractions, both from a financial and a time point of view. Some companies introduce new technology as an emergency measure in order to preserve the company's competitive position and, where this is so, the trend is usually towards a small investment in the retraining of the personnel and the minimum of time devoted to training as is necessary to ensure the smooth running of the production process.

There are indications that where there is a lack of systems' thinking and project management expertise in enterprises, the longer-term, strategic needs and aims of the organization do not receive full consideration. What might appear to be a satisfactory answer to technological change within the enterprise in the short-term might not always be in the best long-term strategic interest of the company. This means that the management and the trade union repre-



Steve Benbow/NETWORK

Most employees lived in long, shabby rows of featureless houses within walking distance of the place of employment in an environment heavily polluted from the manufacturing process going on in their midst.

sentatives must be trained to introduce and manage technological change in the enterprise with a good, clearly planned long-term perspective. Failure to develop such a long-term perspective, based on a realistic assessment of the company's strength and weaknesses, might only enable the company to obtain a fairly short-term advantage from introducing the latest technology. Recent research surveys in various countries have indicated a lack of training opportunities in project management provided either by external or in-company training resources.

The management of technological change is also a subject of vital importance to employee representatives in the enterprise, and research in various countries has shown that where a good dialogue on the introduction of technological change takes place, before, during and after the implementation period, the result of the technological change has usually been positive.

Technological change and creative opportunity

As the technological advances open up new possibilities for the organization of work, and relieve many people of noisy, dirty, boring jobs, some of which were injurious to the employees' health, so do potential opportunities for more creative, responsible tasks appear, but this implies the need for approaches to training, to self-learning facilities, that do not fit into the previously prevalent concepts about training aims and methods.

Relieved of much routine, repetitive work, people have the opportunity to use more creative talents related to the organization and supervision of their work.

In general, it is observed that where new technologies are introduced into factories and offices, the employees find themselves in a situation where some of the functions previously only carried out by the management staff are now being spread out further down the hierarchy, with individual employees assuming a measure of responsibility for planning and supervising their own work within a given outline plan. This in turn entails the need to take a new look at the content and aims of training and retraining programmes and a realization that it is no longer sufficient just to train people to operate machines.

This gradual diffusion of management responsibilities makes it imperative for senior managements to integrate planned human resource development programmes on an on-going basis in their company strategic plan.

During the decision-making and introduction phase of a technological change programme in enterprises, the senior management are, to a very large extent, dependent on the know-how of middle management, but it is precisely the middle managers who are most at risk once the new computerized systems are, with their knowledge programmed into them, operational. Here it is important for the middle management personnel to have access to upgrading training which will enable them to continue to play a valuable, creative role in the enterprise.

Without the routine work in factory or office, the role of the workers can either be reduced to that of a supervisor, watching several machines doing the work, a task that will disappear to a large extent with advanced systems, with a consequent demotivation danger, or the workers can be upgraded, given more responsible and creative work, relieving senior and middle management of some of their workload, but this is entirely a matter of company policy.

The training challenge

Despite all the uncertainties and the many setbacks that can be expected with regard to various types of technology *en route* to the

Looking like a clinic in its cleanliness . . . with a few super-persons planning and supervising the whole process.

factory of the future, one thing is certain. The optimum, socially responsible use of the new technologies will only come about due to the availability of a well-educated and qualified population. The established, traditional education and training infrastructures are likely to prove unequal to the task of preparing the population for such a working and living environment unless they exploit the potential of the new technologies themselves in learning situations.

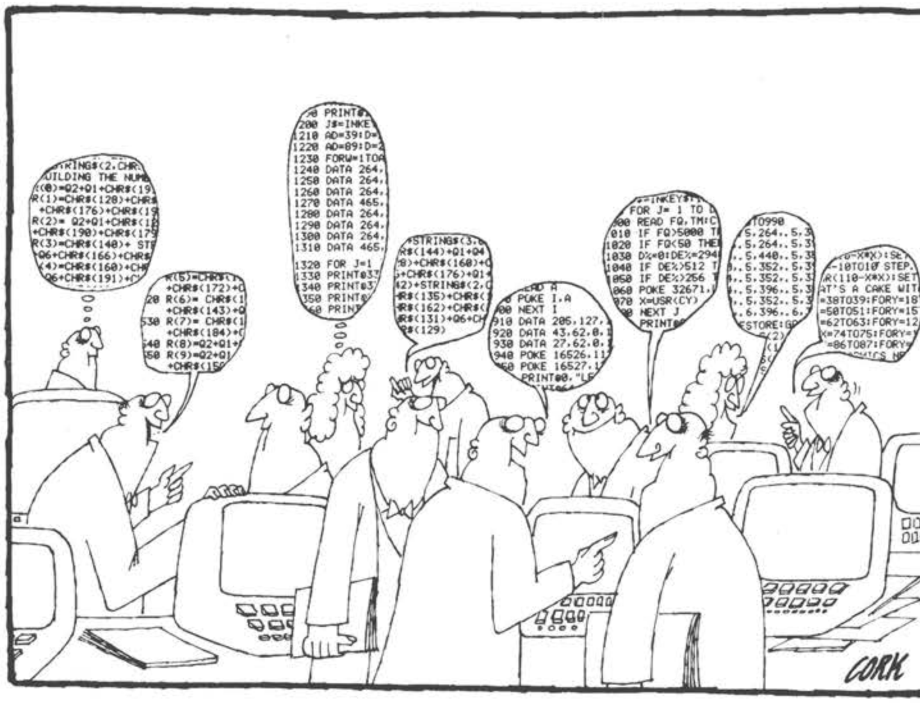
It is doubtful if the full extent of the challenge facing us has been grasped by the education and training authorities in most countries. A recent source has said that the Japanese intend to spend 500 million on developments and applications of artificial intelligence, right across the entire education and training system. This money is to be raised very largely from industry itself. If this estimate is only half accurate, it is an indication of the importance being attached to developments in artificial intelligence on a scale unmatched, to the best of the author's knowledge, in any other country.

Education and training researchers and practitioners in Europe and the USA also see developments in artificial intelligence as an essential step forward in the improvement of computer-based learning. These improvements are seen as offering flexible, interactive learning modes as opposed to the present, limited benefits obtained from computer-based training.

Artificial intelligence, that is, expert and knowledge-based systems, are expected to greatly improve effectiveness and efficiency in learning situations, after the initial heavy cost of preparation of material has been met.

Preparing and updating training for technological change is a strategic question of vital importance to the company. This suggests that the starting point in any training programme has to be with the whole management team, and not only with the sometimes small group of managers who are involved in the planning and implementation of technological change in the enterprise. Project management has been identified as a weak point in a number of enterprises during surveys on the introduction of new technology carried out in various countries in the European Community, yet training for the management of technological change and project management does not appear in many college and university management training programmes.

In the past, Taylorism and Fordism became bywords for close supervision and management, and the breaking down of jobs into small, monotonous, routine tasks which the management considered to be all that employees were capable of doing. The basic employment needs of industry and commerce were also reflected in the compulsory education systems introduced into most industrialized countries in the 1800s, on the assumption that only a small elite of the population was capable of benefiting from education in its broader sense, and that the bulk of the population could only be trained to a level sufficient to enable them to carry out simple functions in factories, offices and mills.



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So far as adult employees today are concerned, the earliest educational experience has convinced many that the system is designed entirely to produce winners and losers, which means that a new attitude and motivation are required to enable those reluctant to embark on updating training programmes to benefit from modern learning techniques. Where children happily work with micro-computers, and quickly understand how to use them, many adults have difficulty with the basic understanding of how to operate them.

Training staff, and all other employees and managers will have to become more familiar with new technologies in learning situations to keep abreast of developments affecting their jobs.

Improvements in artificial intelligence, expert, knowledge-based systems will increase the efficiency of computer-based learning and on-the-job training, using on-the-job open learning systems, and the development of close collaborative links with local education and training institutions, to form an integrated learning environment, will be essential to enable people to keep up to date with frequent changes in the work situation.

So far as development towards the factory of the future is concerned, the training of engineers and high level technicians and maintenance personnel is a key priority area for action if the Member States of the European Communities wish to maintain a significant position in the manufacturing world. The urgency of this need appears to have occurred to many countries rather slowly, in comparison with the enormous effort being made with the training of these categories in the United States of America and in Japan.

Training of management and supervisory personnel in the basics of computer-based technology, in systems thinking and project management techniques are also priority training needs, but it is the systematic, imaginative and well-planned, on-going training programme for the whole team that will produce the winners among tomorrow's factories, just as it does today, except that it will be a more complex task requiring a high level of general education and constant updating.

Conclusions

The factory of the future is only a symbol for what we, today, conceive as a very advanced state of technology. But technological advance effects everyone, it is not confined to the office or factory. Advances in technology are also significant for health care, information handling and interactive systems in a wide variety of applications, not least of which will be technology in the home.

Today's factory is the factory of the future for the 19th century population.

The first industrial revolution in Europe caused a massive social upheaval, involving migrations on a huge scale from the land to the manufacturing and commercial centres. Men, women and children worked long hours in physically exhausting conditions and in many cases, in working environments that brought to mind pictures of Dante's *Inferno*.

Most employees lived in long, shabby rows of featureless houses within walking distance of the place of employment, and often in an environment heavily polluted by smoke and noxious fumes from manufacturing processes going on in their midst. Most people were so poorly paid that they could not afford essential medical or dental treatment, and became a captive market for the enormous flood of cheap patent, pain-killing medicines which became so popular a hundred years ago.

Workers from the 19th century would hardly recognize the working environment or living conditions of today, but the progress has been very slow. The steam engine dominated the world for a very long time, but what is more serious is that the steam engine mentality has outlived the steam engine.

An extreme view of the factory of the future is of a production facility, looking like a clinic in its cleanliness, brightly decorated and with a few super-persons dressed in white coats planning and supervising the whole process. On the factory floor, there is almost no one to be seen.

In Japan, the FANUC plant referred to earlier runs during the night without lights on. Robots do not need light to operate. Where artificial vision is used this can operate with individual infra-red lighting.

We should not forget that people used to laugh at Orville and Wilbur Wright until that historic December morning at Kittyhawk in North Carolina in 1903.

The disturbing thought for education and training people – the Wright brothers were largely self-taught.

Creativity, vision and the courage to experiment are the keys to technological development and these prerequisites have not changed much over the centuries. But imagine what would have been possible for the Wright brothers, and hundreds of other brilliant inventors, had they had the benefit of computer-aided design facilities.*

Here lies the great difference from the past. Technological development in the past concentrated largely on replacing human muscle power, today's technology begins to encapsulate some of man's knowledge, and here we have development of a different magnitude, which will increasingly pose challenges to our education and training systems.

As a Swedish economist once said 'I know I could get more out of this machine if only I knew how to ask it'.

* Maybe the Wright brothers' aircraft, theoretically right according to the computer-aided design system, might not have flown in practice.

Günay Ulutunçok/LAIF

How the factory is changing

'Variable geometry': technological change in Europe

Dr Paracone

The latest generation of aircraft is called the 'variable geometry' aeroplane, in reference to its ability to vary its wing angle at different speeds. Similarly, the next 10 years will see a new 'variable geometry' industrial and manufacturing generation in Europe, one that will advance at varying speeds. This is only natural in so complex and varied a situation, where concerns of all sizes co-exist and where some sectors are far advanced in the process of restructuring while others have come only halfway.

One curious factor should be kept under observation: in some of the more flourishing sectors the number of small and tiny firms is growing while there seem to be fewer medium-sized companies. In some cases this may be coincidental, but it may denote a trend along the lines of what is happening in America.

With a production system as varied as it is in Europe, it would be rash to try to quantify the precise extent of technological change that will be introduced into companies or to make any hard-and-fast forecasts as to employment and the changing nature of jobs.

New variables are also emerging. In companies and industrial sectors that have progressed further along the road towards redevelopment, for example, people are starting seriously to question the desirability of automating plant. Or rather they are trying to determine the precise threshold at which investment in automation ceases to be 'a good thing' and starts to be 'not very good value for money', because the potential increases in productivity and flexibility are acquired at too high a cost.

DR PARACONE, Head of the Giovanni Agnelli Foundation Research Programme

The move towards process innovation is continuing, but people are starting to pay more heed to factors such as design intelligence and different ways of organizing production that promote substantial and significant increases in productivity without increasing the extent of automation. In other words, automation is unquestionably a vital component of change, but there is some doubt as to whether by the year 2000 it will still be the most common factor in innovation (as has been the case over the past few years). Other organizational aspects of change might come to the fore (the term 'organization technology' is creeping into our vocabulary). The aim will be not just to reduce labour costs by replacing manpower with machines but also to reduce operating costs and capital investment while rendering the production process more flexible. This will be done by making better use of the machines, and also by making more intelligent use of people's skills and ability to accept responsibility. What I mean is that integrated production systems can be constructed, featuring a network of links and 'zero loss' transfer points between each phase of production and between those phases and the suppliers' production processes.

Today those processes are separate, often leading to all too familiar problems with stocks and, more generally, surplus production capacity.

Fewer jobs? Yes, but . . .

This is not all: when considering the subject of falling industrial employment, a measure of caution is advisable and certain distinctions should be made.

The reason is that the only true revolution generated by the introduction of 'artificial intelligence' into the factory – and we shall come back to this subject – lies not in the production cycle but in the reduction in employment in the manufacturing industries.

Admittedly this is a structural trend, at least until such time as the forms of mass production associated with new materials, biotechnology and nuclear fusion enter the industrialization phase. This will happen at about the end of the century or, in the case of nuclear fusion, even later.

Nevertheless, it is in those very areas in which the process of industrial restructuring is nearing completion – and here I refer to Italy, since I do not have specific details on other countries – that a new idea is gaining ground: development projects that accelerate the overall modernization of a whole geographical area and create new jobs there. The projects may be in traditional fields such as infrastructure or in new fields such as telematics. They may be on a small scale, as with the systematic maintenance of towns, housing, roads and the local area. They may be development projects on a national, regional or local scale along the lines of major European Community projects such as Esprit, in other words involving a string of companies. Such projects may have some public-sector funding but as far as possible they will be funded from the money market (since they offer a secure if long-term return, like infrastructure projects). They may be able to attract investment from small savers, as in the case of maintenance projects.

Not cut-and-dried predictions, but a clearer idea of future trends

The purpose of this lengthy preamble is to warn against being too dogmatic in predicting the future. Nevertheless, a reasonably clear picture of certain trends is emerging, and it will help to reduce uncertainty as to what will be happening in the workplace in the near future. The goal we have set ourselves has been to identify those trends.

How is the factory changing?

What are the new trades on the shop-floor? What training is needed for the new jobs and for jobs which, without being new, are changing radically?

The Agnelli Foundation is the largest foundation in Italy and an ideal observation point for the changes taking place in the industrial world to which it is so close. In liaison with CEDEFOP,[1] it has recently carried out complex and detailed research in the field in order to:

- build up a picture of 'typical technological cycles' in seven sectors of industry – printing, engineering, electronics, rubber, plastics, wool textiles and cotton textiles – making up 41 % of Italy's manufacturing industry, and at the same time to find out what plant engineering is prevalent today in the more dynamic companies;
- identify the craftsmen who work on each stage of the production cycle in those sectors;
- advance predictions as to the ways in which production cycles and the craftsmen who work in those sectors will have changed in seven years' time, with special reference to:
  - the plant engineering predicted for 1992 – 93, according to machine tool manufacturers, process technology suppliers and major companies in the sector with their own technological expertise;
  - two alternative work organization configurations: the traditional/Tayloristic configuration, or a complex configuration based on multi-skilled, multi-function operatives;
  - the type of production workers (new, partially new and traditional) who will be needed in the medium-term future in the industrial sectors covered by the research;
  - an exploration of the kind of training that will be needed as a result.

It would be rash to attempt longer-term predictions, since it is impossible today to build up a reliable picture of what the factory and the office will be like by the year 2000.

This research, it should be repeated, has not led to a cut-and-dried statement of what technologies will be used in the future or how work will be organized, but it does give some idea of the trends and highlights some practical working opportunities for companies.

The second trend that is becoming apparent – the first being the growth of small firms in some sectors – is that technology is neither a revolution nor a rebirth, even though it may be altering the face of the factory. The sequence of phases that make up the production cycle is not being violently disrupted. The only revolution has been in the printing of newspapers and magazines, where the composition stage is on the way out, and printing with metal type giving way to photocomposition. Compositors used to be the elite of the printing trades. In the early years of this century, to quote a colourful illustration, typesetters in the printing works of the leading Italian newspaper of the time were entitled to 'wear a dress sword'. Today many newspapers are typeset by the journalists who write the articles, by-passing the 'separate' typesetting phase, and this is likely to become the general rule over the next seven years. Even so, it is the only instance of a probable structural change in a production cycle to have been found in the course of our research. Production cycles in the engineering, rubber, plastics, textiles and other industries have remained unaltered.

Technology: Hobson's choice

Bearing in mind all the reservations expressed, automated plant technology is in a sense an inevitable choice for companies whose prime aim is growth.

It is equally inevitable that – in a production system made up of companies that differ widely in size, where markets too are on differing scales and where there is such a variety of product mixes – the ways in which new technology is introduced and the timing of its introduction will differ as well. Two factors, however, should be stressed.

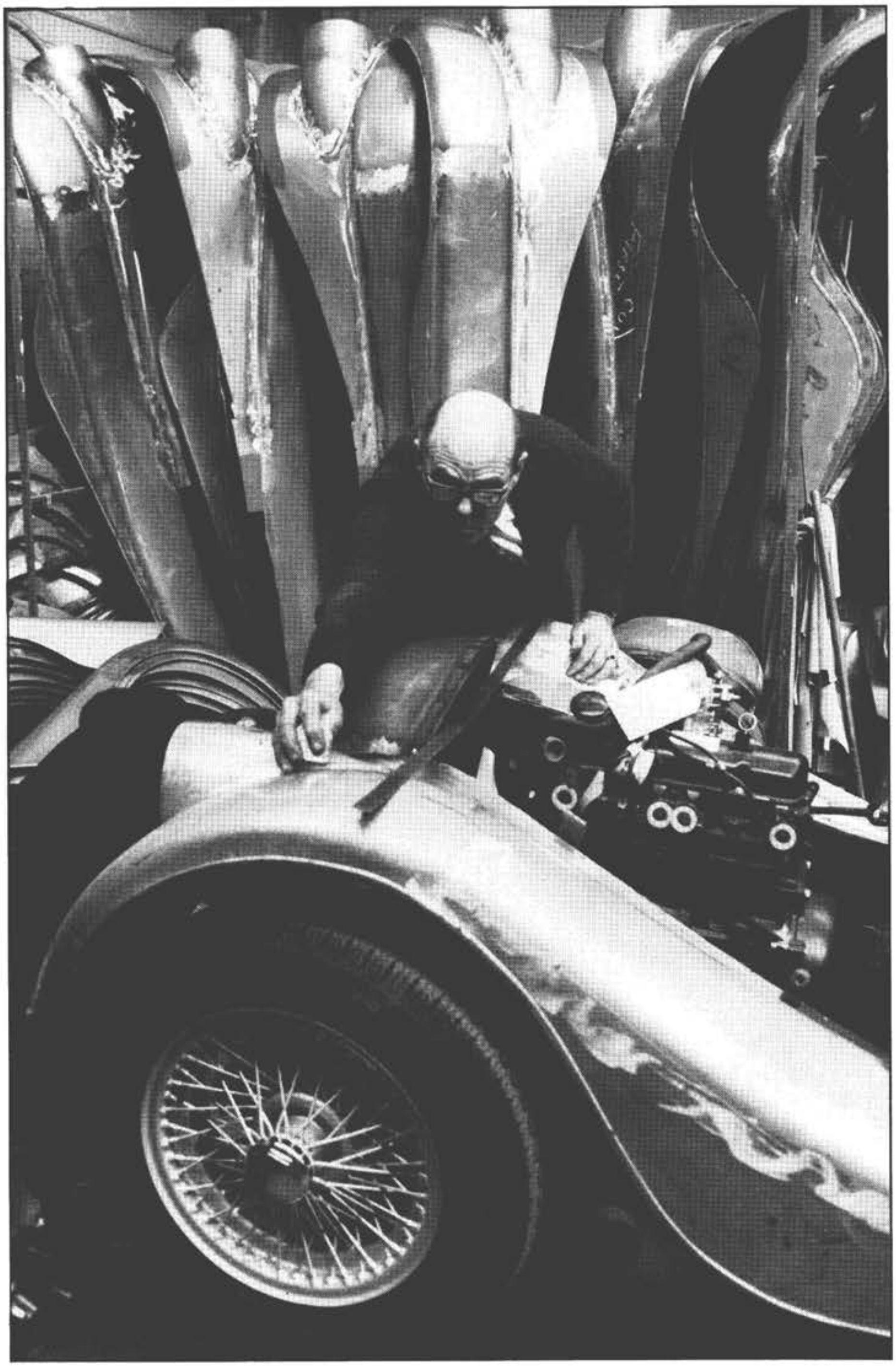
Every company has to think about the problem of renewing its plant over a seven year period and, in tackling that problem, it must look at the market to find what is available in the way of machine tools. That market, which in essence consists of a relatively small group of manufacturers, will be offering fewer machine tools incorporating electrical/mechanical engineering technology and a growing number of automated plants. Since all automated plant tends to come from the same manufacturers, the machines will come in more or less the same family groups, whether they are automated units or numerically controlled instruments designed for small firms or whether they are large-scale plants for major companies. This means that the machinery used by large and small producers alike will be likely to be technologically very much of the same type.

The technological scenario that has become apparent in the course of our research is already a practical reality in certain pacemaking firms, both large and small, and it will become more and more common over the medium-term future. There is, however, less certainty as to future developments on the organizational side; these depend on the attitudes of individual entrepreneurs, which are not always easy to predict.

Choice of work organization: a matter of discretion, or is it?

As plant is automated and as it incorporates a growing amount of artificial intelligence, some of the newly emerging ways of organizing work are becoming more advantageous in terms of promoting productivity and flexibility and optimizing the use of plant and operators, others less so.

In other words, the choice of how work is managed – which used to be the one field where the entrepreneur had scope to exercise discretion – is becoming more 'neutral' and subject to more constraints.



Patrick Ward/NETWORK

This is what I meant when I said that our research gives some indication of the opportunities. The opportunities open to the entrepreneur and manager seem to lie in new methods of managing work. They will no longer be the compartmentalized forms of scientific management first advocated by Taylor but will extend the field of action of individual operators and give them a greater sense of responsibility for the work they do.

The starting point is the change in technical variables, in other words the transfer from mechanization to automation.

The advantages of new ways of organizing work

Automation, in other words, makes jobs less repetitive and paves the way for that 'new way of working' which until very recently has been much discussed but in little evidence. Automation increases the value of work to the employer and makes it more satisfying for the employee. The closer one comes to maximum innovation and the more sophisticated the plant – the more capable it is of self-diagnosis and self-correction, the easier to regulate via monitors and keyboard-activated computerized procedures – the more the entrepreneur will appreciate the feasibility and desirability of discarding Tayloristic methods of work management and adopting new methods that call for people with a range of skills performing a range of functions, whether they are shop-floor operators or skilled craftsmen or, at a higher level, whether they are systems technicians or engineers.

Simplifying the range of trades in the workplace

In the second place, automation helps to simplify the range of trades to be found on the shopfloor and in the office.

With a mechanized system, the work of handling and processing products is done by the machine. The operator's job is likely to consist of supervising the machine, loading, unloading and positioning, and maintenance.

With an automated system, on the other hand, it is the computer that regulates the machine. The information system is different too: where it used to be simple, it is now complex.

The physical structure of the logistic system as well as the instruments for managing that system also evolve. In changing the organizational system, technical variables also bring about an evolution in shopfloor work away from the physical processing of products and towards monitoring tasks, although the degree of responsibility may differ.

In our research, the aim has been to determine the number of tasks and operations performed by the operator, his level of specialization (standard of education, training and experience) and his level of management (his relative ability to arrive at decisions for himself wherever such working choices are needed).

The kind of training needed will obviously depend on the choice of plant, organiza-

Heggemann/STERN

tion, computer technology and flow management.

To generalize, three possible levels of job skills have been identified:

■ work that consists purely of supervising signals from the machines (automated type of work organized along traditional, Tayloristic lines;

■ work that includes quality control tasks and taking simple remedial action;

■ work which, in addition to the above, includes maintenance jobs when the machine indicates that they are needed and when they can be performed by direct access, using standard tools.

At the first level, all responsibility for maintenance is in other people's hands. At the second level, the operator is required to be able to carry out maintenance on individual components of the plant, although there is a central pool of people who take remedial action of a more general nature.

Eight shop-floor skills

What is striking – based on what is happening in companies that are the technological pacemakers – is the fairly clearcut prospect of seven or eight jobskill archetypes emerging over the next few years. In each manufacturing sector, as is obvious, these seven or eight archetypal skills will break down into a variable and fairly large number of individual jobs. This is clearly outlined in the research report when it depicts the medium-term future of production cycles and gives some indication as to the role of operators in the phases and sub-phases of those cycles. It highlights the fact that manual work will not disappear but will continue to be part of the production process over the next 10 years.

In attempting to understand the future and deciding on the appropriate training routes, it is those archetypes that need to be identified rather than individual crafts.

The archetypal jobs can be broken down into two groups: direct production jobs (the machine operator, the semi-skilled craftsman, the skilled craftsman and the shop-floor technician), and indirect production jobs (the general technician, the maintenance technician and the general maintenance technician).

The machine operator's functions are merely to supervise a machine. He needs no more than brief training. His vocational expertise depends on the number of tasks with which he is entrusted. He is to be found in companies where work is organized along traditional (Tayloristic) lines.

The semi-skilled craftsman's tasks are similar to those of the machine operator, but he also sets up and adjusts the machinery he operates. His training includes instruction in manual skills and general familiarization with the technology and operating principles of the machinery he uses. He is to be found in medium-sized concerns organized along traditional lines.

The skilled craftsman's tasks are supervision and detailed non-routine action, but only on the type of machinery to which he is assigned. The training requirement is the acquisition of a thorough technological knowledge of specific categories of machinery, and it will vary depending on the functions he is called upon to do. The skilled worker is used by companies where work is not organized along Tayloristic lines and which use simple information systems.

The 'shop-floor technician' is the newest type of operator. He performs many functions in that he is capable of a range of tasks: setting up machines, production work, in-process quality control, materials handling and routine maintenance. His job is typical of a more advanced organization not run on Tayloristic lines, and he is to be found in workplaces with a high level of automation and monitoring, where the work being done by the machines can be monitored via a VDU terminal and any adjustments or repairs can be effected by keying in instructions and activating computerized procedures.

What is new about the shop-floor technician's work is the fact that he does not observe what is going on directly but takes a more global view; to do this he must have the ability to interpret the symbolic language of information technology in the light of information provided by the computer.

The shop-floor technician carries out maintenance work himself, although he may call on outside help for major or highly specialized maintenance jobs. He is a person who needs thorough job training. If he works on plant, he must be taught to use complex information technology and he must have acquired a capacity for logical and abstract thought (knowing how to use symbolic language). He must be able to take decisions quickly and step in not only to correct discrepancies and deal with breakdowns after the event but also to take preventive action by being able to interpret 'signs of weakness'.

The production technician has a different vocational profile because he must have a specific knowledge of a certain area of production. He is an expert in one segment of production and/or a particular type of machine. The required training is obviously that he should be thoroughly familiar with the machines and equipment for which he is responsible. He is to be found in medium-sized and large companies organized on both traditional and non-traditional lines.

The maintenance technician is responsible for ensuring that various types of machine function properly and without a break, but he works on only the mechanical, hydraulic, pneumatic or electrical side. In other words, he is an operative with basic knowledge of a single trade: he may be a mechanical or hydraulic engineering maintenance technician, etc. He is found in firms where work is not organized on Tayloristic lines but where the flow is rigid, or in medium-sized and large companies where the flow is asynchronous and whose organization is Tayloristic.

The multi-skilled maintenance technician must have a systematic knowledge of more than one technical trade. A typical example is the mechanical/electronic maintenance engineer, who carries out both kinds of maintenance work on plant. He has a range of responsibilities in a number of fields but only one function, that of maintenance, unlike the shop-floor technician who performs a multi-functional role. The multi-skilled maintenance technician is typically found in medium-sized and large companies which use advanced automation both for manufacturing products and for managing logistic flows, and where the pattern of organization is innovatory.

To these archetypes could be added the machine setter, who is somewhat like the shop-floor technician but works on plant without the help of a monitoring system.

If these are the archetypal craftsmen of the future, then, fresh thought should obviously be given to training so that it can be more closely related to the new situation.

If work is to be decentralized, for instance, a different type of training will be needed. The shop-floor technician is a case in point. Operators not directly engaged on production work must acquire skills in other technical fields if they work in a factory where the flow is rigid and where the use of a single-skill maintenance technician is advisable. In a factory where the flow is asynchronous and it is better to use multi-skilled maintenance technicians, they will need specialist training in several trades and must have managerial abilities.

Who should do the training?

Who will be responsible for providing these kinds of training?

It could be argued that job-related training is the employer's task (i.e. all practical training and a substantial part of learning how to apply skills in the case of maintenance technicians). The ability to use one's own judgment should be acquired in formal education (the school) and in the workplace. Schools and training centres should be far more active in teaching electronics and information technology skills, raising the level of technical and vocational knowledge and helping people to acquire the powers of reasoning and conceptualization needed, for example, in managing monitored plant.

The research findings and the international debate

One question remains: how do the findings of this research relate to the many current studies on the changes in organization and occupations being brought about by the 'wave of new technology'?

One point of great interest arises in connection with the papers given to the summer 1986 conference on 'new production systems' organized by CEDEFOP and the City of Turin (which, as councillor Franca Prest reminded us, has the highest concentration of research laboratories and industrial automation producers in Italy and is more generally one of the strongest industrial areas in Europe, having finally three years ago emerged from the bitter period of wholesale restructuring).

At the CEDEFOP conference, there were essentially two schools of thought and prediction as to future changes. One school consisted of the researchers who had produced a 'profile' of a fairly substantial sample of companies located in their respective countries of origin. The second school was made up of experts who, in mapping out their predictions, took as their starting point the experience of market leaders, or at least whose research was based on outstanding industrial companies.

With apologies for what may rightly be regarded as a gross over-simplification, the first group displayed a great deal of caution: since the situations encountered at grass-roots were so varied, it is difficult to tell whether technology is polarizing skills, with the 'button-pusher' operative at one extreme and the super-technician at the other, or whether it is likely to push skills constantly upwards to the medium-to-high levels. In other words, it is hard to say whether we are moving towards a new and more sophisticated type of Fordism or towards work organization methods that call for multi-skilled, multi-functional operators. The second group, on the other hand, was clearly inclined to predict that innovatory forms of work organization would prevail, although they also stressed the need to discard Taylorism and move towards the integration of functions so that full advantage could be taken of the potential of new technology.

Among the exponents of the first school we could place Rosanvallon, F. Prakke-C. K. Pasmooij and R. Bilderbeek. Rosanvallon himself, moreover, expressed his personal belief that we are moving towards an 'intellectualization' of work.

Hollard comes halfway between the two schools, with his affirmation that the neo-Fordist tendency in situations where there is a high level of automation is typical of employers whose aim is solely to bring down costs, whereas the tendency to adopt more flexible forms of work organization and production is typical of employers whose prime aim is growth.

At the Turin conference, however, the most explicit exponents of the second school of thought (whose starting point was the experience of companies in the technological vanguard) were J. Bullinger, J. Warnecke and P. Lente, who stated in their paper that: '. . . it will become necessary to reconsider the traditional kind of distribution of functions with the aim of achieving a reduction of delays. . . . the thinking in terms of organization forms with centralized and vertical distribution of functions that has been practised so far will be superseded for these reasons by the integration of all functions which are necessary in performing a task . . .'. We are in full agreement with this statement. It was no coincidence that comparable views were also held by company men like P. Appoggetti of Comau, a leading firm in the field of robotics, and C. Besusso of Fiat.

The difference between the two schools of thought, therefore, is between predictions based on extrapolations from the current situation, and guidelines as to 'what employers will have to do' if they are to take full advantage of the opportunities offered by technology.

Our research has been along the second of these lines. Not only is it an exercise in forecasting but it is also an indication of the opportunities. We believe that, if this indication is based on what is actually happening among the market leaders it may be of help to firms who find it harder to 'read the changes' and to those people who have to plan for vocational training over the next few years. In other words, it may be of help in supporting and managing change and in reducing the uncertainties.

Perhaps the greatest problem in all our advanced societies today is that of 'educating in change'.

[1] 'Come cambia la fabbrica', edited by Giorgio Fardin (Managing Director, Telos Management), Massimo Casoli (Telos) and Luigi Cerato (Fiat Auto). The research project was directed by Corrado Paracone (Agnelli Foundation) with the support of Corrado Politi (CEDEFOP).

Towards an anthropocentric approach in European manufacturing

Peter Brödner

Changing markets and global competition

In the last two decades the world's markets have changed dramatically. The markets in industrial consumer goods and, therefore, capital goods have gone from steady expansion to a tendency to stagnate. As the machine tool industry shows, the capital goods industry is particularly prone to stagnation because output in this sector is as a rule growing faster than the functional value of its products.

This continuing global trend will not be influenced by the considerable potential inherent in the unsatisfied needs of the developing countries since the terms of trade in general and the enormous debts of these countries in particular will impede their efforts to convert needs into purchasing power for a long time to come. Consequently, world markets are and will continue to be confined to the highly industrialized and newly industrializing countries of North America, Western Europe and South-East Asia (the Comecon countries' links with these markets being no more than tenuous; see Fig. 1).

The generally low growth rates in these restricted markets, reflecting the change from expansion to stagnation, indicate that the nature of competition is also changing. While suppliers were largely able to dictate the terms when markets were growing, cut-throat competition is now giving the consumer the power to insist on products adapted to his needs. Under the market conditions engendered by such competition, price and quality are no longer the only means of survival. The ability to adapt products to a growing variety of customer requirements and still guarantee short delivery periods is becoming almost more important as a factor in competition. As the following shows, this has a major influence on internal operating conditions throughout the manufacturing process.

The three competing regions of the world differ markedly in their industrial structures. The differences in productivity, product mix, production processes, available

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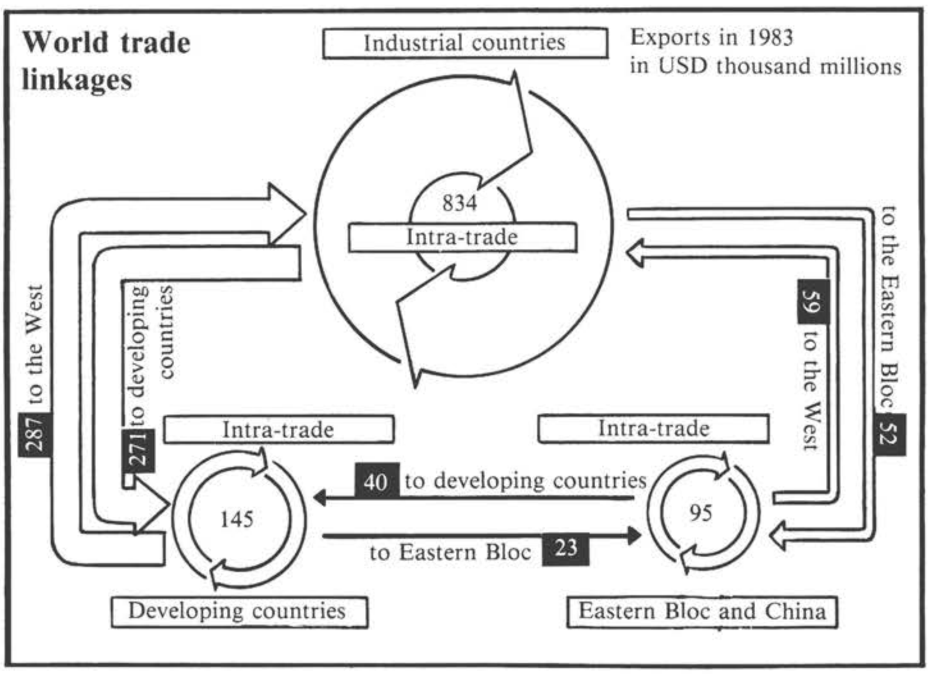

Fig. 1: Main flows of world trade in 1983

Heggemann/STERN

Group technology.

skills and industrial relations can be described as follows.

In North America huge and fast expanding domestic markets led to the development of an extremely sophisticated form of mass production, due largely to the rapid process of industrialization in the north-east. This was accompanied by the emergence of a very efficient engineering and machine tool industry producing high-performance capital goods. As most of the workers were unskilled or at least unaccustomed to working with metal (many were southern blacks and European immigrants), but with minds of their own for all that, a great effort had to be made to gain and retain control over production and to ensure that work was done properly and on time.

It was thus necessity rather than chance that gave rise to Taylorism and Fordism in the USA. They became widespread in this region and eventually the dominant production paradigm of the industrial world. In recent years, however, the picture has changed considerably. The decline of productivity (annual growth rates falling from an average 2.8 % in the 1960s to 0.7 % in the 1980s; Dumas 1986) shows that for a variety of reasons a process of de-industrialization is under way: while the service sector is growing, the industrial sector is becoming less competitive (cameras, cars, computer chips, machinery, machine tools and tape recorders are familiar examples of this trend).

South-East Asia, economically dominated by Japan, began its industrial rise much later. It did not play a part in global competition until the period of reconstruction following the Second World War. Initially only Japan was able to compete in world markets, but in recent years it has been joined by such newly industrializing countries as South Korea and Taiwan, which have adopted similar development patterns. The industrialization process in this region was again based on the principles of mass production and stimulated by comparatively large domestic markets. But it developed within a different industrial structure, one that was adapted to local industrial relations (Toyotism rather than Fordism; Dohse *et al.,* 1984). The enormous, advanced, multisectoral companies of this region attacked their well-established rivals in Europe and the USA with carefully targeted campaigns. As a rule, they had two advantages: lower costs and more productive manufacturing processes, the organization of work being based on a far more limited division of labour and a highly skilled workforce, although economies of scale were exploited wherever possible (e.g. cameras, cars, low-cost, standard NC lathes and machining centres). Recently, however, their success appears to have lost momentum, as the underlying economics of production begin to conflict with the demands made by competition in stagnating markets.

Although industrial structures, skill profiles and labour relations vary widely in Western Europe, some generalizations are none the less possible. The evolution of its industrial core (i.e. the United Kingdom, the Federal Republic of Germany, Northern Italy, Sweden and Switzerland) followed a different production paradigm. As this region's industrial rise owed more to the manufacture of capital goods than of consumer goods, production to order and in small batches dominated from the outset (Germany's industrial rise, for example, was based on engineering, including machine tools, and the chemical industry; even today the capital goods sector accounts, at about 25 %, for a far larger proportion of total industrial production than the huge car industry, with its 17 % share). With markets stopping at national frontiers, the core of European industry thus developed a specific ability to adapt its products to the requirements of their users ('tailor-made machinery') and accordingly installed flexible manufacturing processes, whose productivity lay roughly halfway between that of their US and Japanese counterparts (see Table 1). This European industrial evolution was accompanied – regardless of all national differences – by the emergence of a more or less highly skilled workforce and of industrial relations which in one way or another laid sound foundations for the assimilation of technological change in socially acceptable forms.

Table 1

Annual growth of manufacturing, productivity (annual output per man-hour) in the USA, Japan and the Federal Republic of Germany from 1965 to 1975

USA	2.3 %
Japan	13.7 %
Federal Republic of Germany	7.3 %

Source: Melman, 1983, p. 164.

If the specific strengths and weaknesses of the industrial structures in these economic regions are considered in terms of future market requirements, Japanese industry seems likely to be much more competitive than US industry. The far more limited division of labour, combined with a more highly skilled labour force, is keeping the growth of productivity comparatively high and also making it easier for Japanese industry to cope with rapid innovatory processes. This is true at least of high-volume production, with its growing economies of scale, provided that this type of manufacturing meets market requirements. On the other hand, Japan's industrial system has relatively limited experience of highly flexible manufacturing to order, even its machine tool industry being no exception.

In this respect, the European industrial core, or at least those parts which have long experience of 'flexible specialization' (Piore and Sabel, 1984) and a flexible manufacturing system and skilled workforce to match, might even fare better. If the tendency for world markets to stagnate persists and cut-throat competition therefore dominates, Europe's position is likely to become comparatively even more favourable, while the USA's industrial system will probably continue to become less competent owing to mismanagement of technology and waste of human resources (Melman, 1983).

However, this potential superiority can be converted into genuine competitive advantages only if decision-makers at all levels become aware of this situation and realize that they must adjust future manufacturing processes, the organization of work and the skills of the workforce to the specific requirements of 'flexible specialization' or, in the case of high-volume production, of 'diversified quality production' (for some countries and industries this will, of course, be a hard lesson to learn). Instead of simply imitating Japan, it is vital that Europe should develop its own manufacturing technology to suit its own needs. The factory of the future is at a crossroads (Brödner, 1986; Piore and Sabel, 1984; Sorge and Streeck, 1986).

The economics of production

Internal operating conditions

The significant change in world markets from expansion to stagnation is having a major impact on the internal operating conditions under which goods are manufactured. Production processes must now

(i) become highly flexible so that they can cope with both product changes and process innovations,

(ii) ensure high levels of machine efficiency and productivity and reduce lead and processing times, and

(iii) enable better-quality and sounder products to be manufactured.

In many respects, the production structures that have so far evolved do not, however, meet these new requirements. The latest findings of a more systematic analysis of the relationships between technological change, the organization of work, available skills and the impact of product markets show that these factors are not mutually determining but linked loosely by certain degrees of affinity. A given product and its market do not determine which manufacturing technology is used, and technology does not determine how work is organized or what skills are required.

	Standardized price-competitive products	**Customized quality-competitive products**
Low volume	Specialized component production *1*	*2* Craft production
High volume	Mass production ('Fordism') *3*	*4* Diversified quality production

Fig. 2: A simple classification of product strategies

Consequently, there is always scope for strategic choices between products, technologies and ways of organizing work. The scope for decisions on alternative product strategies can be described with the aid of two variables: the nature of the competition to which products are exposed and the volume in which they are manufactured. These variables divide manufacturing into standardized, price-competitive and customized, quality-competitive production on the one hand and low- and high-volume production on the other (see Fig. 2; Sorge and Streeck, 1986).

This pattern results in traditional production concepts tending towards either the low-volume manufacture of customized, quality-competitive goods or the large-volume manufacture of standardized, price-competitive goods (Fordism/Toyotism). The availability of high-performance electronic data processing (EDP) has greatly increased the range of product strategy options. Above all, it has opened the way for the new style of manufacturing customized, quality-competitive goods in large volumes (as in the German and Swedish car industries): in short, 'diversified quality production' with potential economies of scale. The 'flexible specialization' strategy is rapidly becoming more profitable and competitive, and smaller batches can be manufactured by traditional mass production methods.

Although these different types of production will probably continue to exist side by side for a long time to come, the main emphasis will be on small-batch production for the strategic reasons discussed above.

The development of small-batch production can be roughly broken down into three stages. At first, labour was divided horizon-

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tally, in accordance with the concepts of Smith and Babbage, which made the gradual introduction of machines possible. Taylor's principles then enabled planning and peformance to be split. In the third stage the vertical division of labour was increased through the introduction of NC machines and the addition of programming to the range of planning tasks. Each of these stages was prompted by politico-economic expectations of better control over production, higher productivity and lower costs and not therefore simply by technical necessity.

The result is the highly differentiated jobshop manufacturing process with its currently very complex design, planning and control functions. However, this method of organizing batch production has serious drawbacks, such as long and variable processing times, an unfavourable ratio of indirectly to directly productive workers and low-quality work (which is none the less far better than the standard achieved in mass production).

Three major economic difficulties in particular have to be overcome by the factory of today;[1]

Firstly, the capital intensity of factory equipment is constantly rising, forcing management to make better use of it (see Fig. 3).

Secondly, the very long and variable processing times due to the functional principle of jobshop manufacturing greatly increase the cost of actual production (see Fig. 4).

Thirdly, the average ratio of 144 indirectly productive workers to 100 directly productive workers in the German engineering industry makes labour costs too high, well organized firms manufacturing comparable products show that by and large a ratio of 90 to 100 is sufficient.

To overcome these difficulties, two opposing production concepts have emerged. They are briefly described in the following (Brödner, 1985).

☐ The technocentric approach The 'unmanned factory'

The technocentric approach essentially retains the jobshop structure of production

[1] On the whole, the following data on the German engineering industry also apply to other European countries.

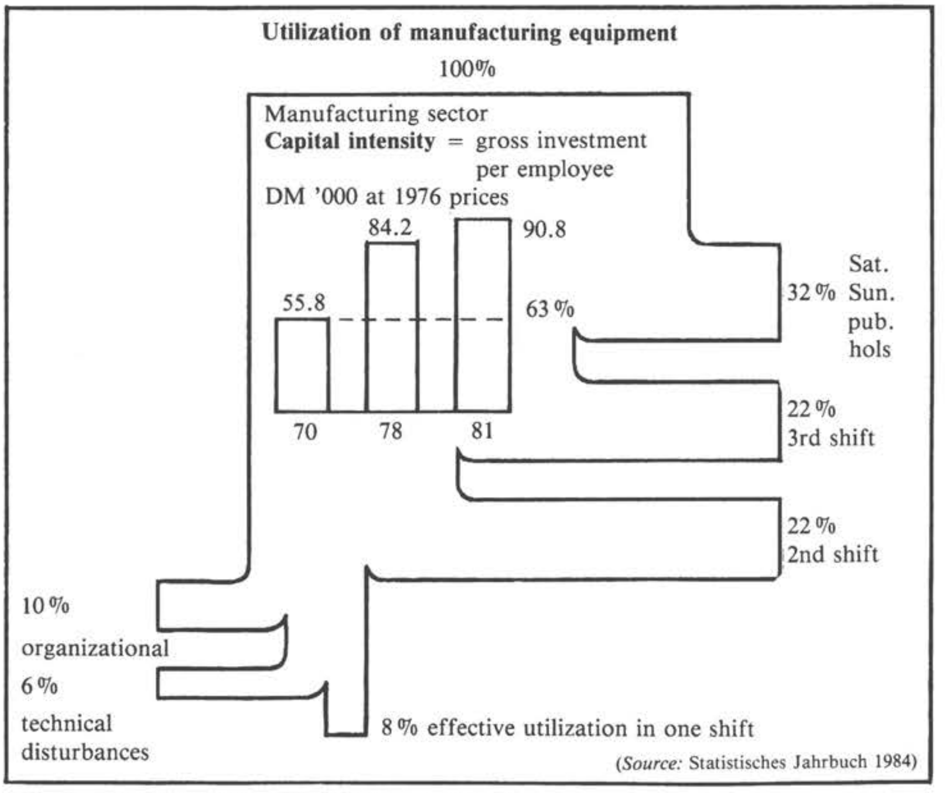


Fig. 3: Utilization of capital-intensive machinery

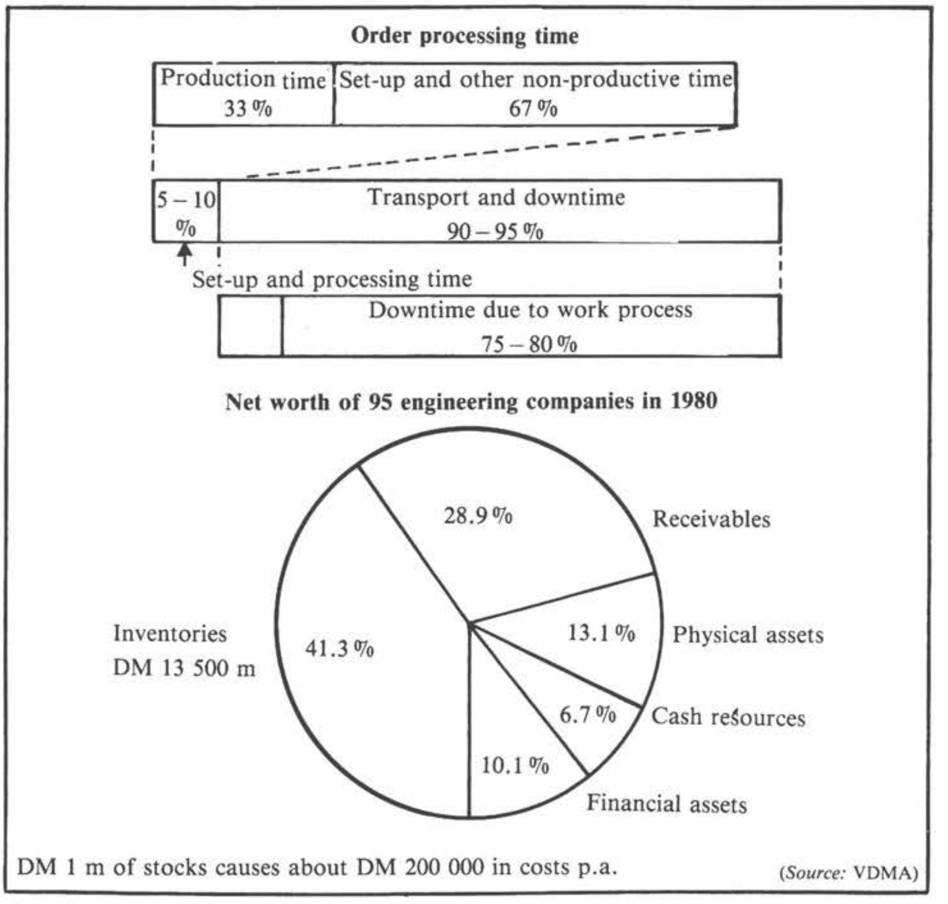


Fig. 4: Processing time and stocks

and pursues the same basic objectives as in the past: reduction of direct labour costs and improvement of control over the production process (Sigismund, 1982).

At shop-floor level management tries to automate almost every aspect of the setting and operation of machine tools and handling systems. Their efforts are concentrated on automatic part and tool change, measuring devices and monitoring systems. They are, of course, constrained by the rapidly rising cost of the equipment needed for these purposes. Although fully automatic operation may be possible on occasions, gaps that have to be filled by human beings still remain.

The greatest potential for rationalization, however, lies in the engineering office, where numerous attempts have been made to automate aspects of the immense amount of information processing work involved (which can easily account for over half of the total workload). As the introduction of computers must be preceded by analytical models of the process to be automated, with work content and sequences reduced to data formats and algorithms, they were first used in areas which were most accessible or where the economic effect was likely to be greatest, e.g. design, process planning, stock control and scheduling. All these systems led to minor savings of time and costs, but they did not fundamentally improve the situation, especially as development and application in isolation make subsequent integration very costly (Sigismund, 1982).

The spread of such CAD and CAM systems coincided with a new polarization of skills. To enable the systems to be used effectively, the goals and sequences of work process are formalized in the extreme. At the lower end the user forfeits important aspects of his former tasks and is exposed to new constraints because of the formalism of the system, while at the upper end the work of the few who plan the use of the system and ensure its continued use requires a wider range of basic skills. In addition, the differentiation of functions results in a more extensive division of mental work, which has similar effects (Beitz, 1983; Benz-Overhage *et al.*, 1984; Hirsch-Kreinsen, 1984; Wingert *et al.*, 1984).

The repeated and error-intensive input of the same data in different functions calls for the integration of the assistance provided by computers. Highly formalized and detailed knowledge has made more functions of mental work accessible to computers. The present situation is thus an indication of both the need for the creation of a computer integrated manufacturing (CIM) system and of the requirements that must first be satisfied. It must combine at least three basic building blocks:

- a common data basis with which all functional programmes are able to interact, since most data are used in several functional areas,
- a data highway enabling subsystems to be linked, since a CIM system will cover a large geographical area,
- data exchange interfaces, since both users and suppliers must be able to combine subsystems of different origin.

Integration is not, however, the only problem posed by the technocentric strategy. Another is raised by the need to create stocks of knowledge and expert systems for use in all key areas of production (cf. the fifth-generation computers now being developed). There are primarily two reasons for this: one is management's fear that, once most of the work done by human beings, apart from a few highly placed experts, is reduced to low-grade functions, conventional programmes will be unable to cope with complex and changing situations; the other is management's desire to have expensive human expertise for themselves. Although this development is accompanied by great hopes, inflamed by the 'artificial intelligence' community (Feigenbaum and McCorduck, 1985), there is some doubt whether the promises will ever be kept (Dreyfus, 1979).

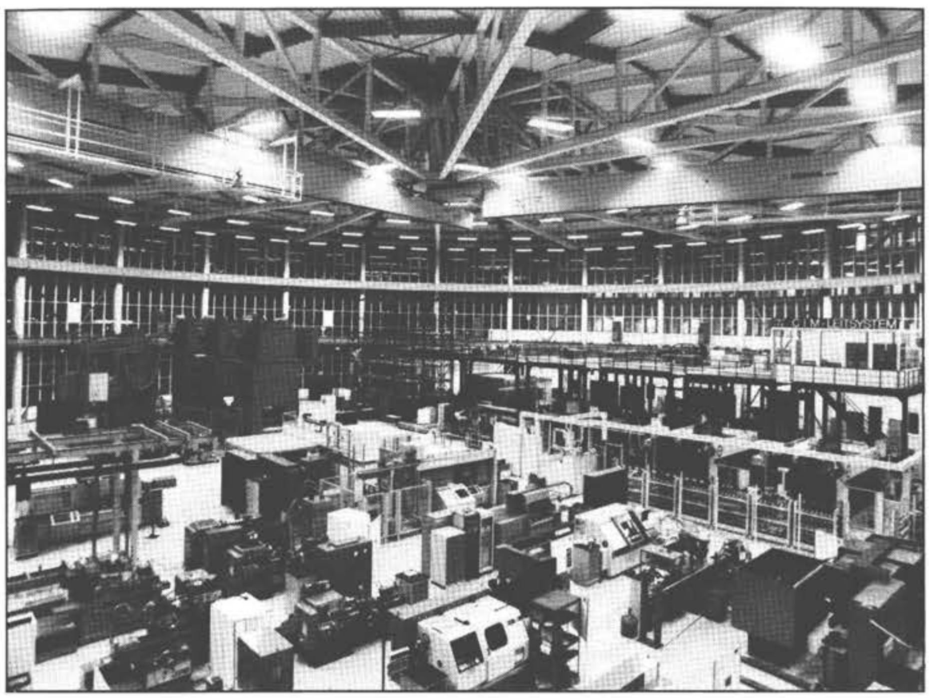
This far-reaching development will culminate, on the one hand, in an integrated computer system, on the other, in a fragmented work structure. The computer system will incorporate most of the production know-how, while the worker's skills will wither for lack of use.

However, the concept of the 'unmanned factory' faces certain obstacles, making its success appear doubtful.

Firstly, the extremely high costs and risks associated in particular with the necessary software are beyond the financial means of many small and medium-sized firms. Despite their growing economic importance, development would pass them by.

Secondly, firms adopting this strategy would be relatively inflexible as regards both batch changes and product and process innovations, since any change to a customer's order or to a piece of production equipment would first have to be modelled by the computer system. In the long run, a firm might even lose its innovative ability because man's production know-how and creativity would gradually dwindle. All this contrasts with market requirements.

Thirdly, while existing skills would no longer be used, non-existent skills would be needed. If these difficulties are to be avoided, an alternative approach must surely be sought.



☐ The anthropocentric approach – Skill-based manufacturing

In the anthropocentric approach the principles governing the organization of small-batch production are completely different. By splitting orders rather than work, jobshop manufacturing, with its fundamental deficiencies, can be converted into group production, in which part families are manufactured in their entirety.

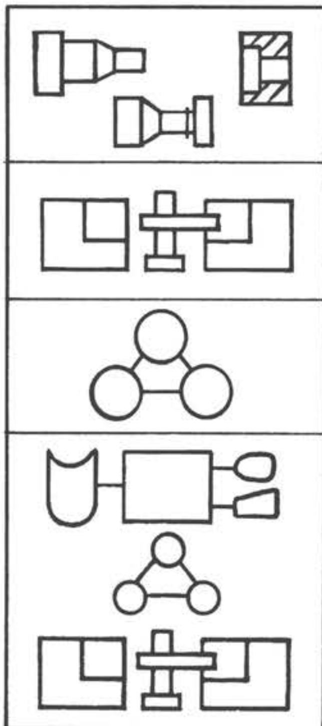
The principles of group technology can be applied in four main stages in compliance with the fundamental organizational aspects depicted in Fig. 5 (Ahlmann, 1980; Mitrofanow, 1980; Warnecke *et al.,* 1980; Williamson, 1972).

In many cases, management is content simply to break the whole range of parts used in a form down into part families (first stage) in order to achieve greater transparency and better classification for the geometric and manufacturing data banks (drawing, lists of parts, process plans). However, the group technology idea clearly denotes a general organizational concept, not just an individual technique.

If organizational changes are confined to the application of the first principle, the attainable economic effects will not be exhausted by any means. Practical examples in fact indicate that major benefits are gained only at the higher levels of group technology. Compared to jobshop production, these benefits can be described as follows (Ham, 1977; Spinas and Kuhn, 1980; Warnecke *et al.,* 1979; Williamson, 1972):

- short processing times: time savings of 60 to 88 % and savings of 44 to 60 % of in-process stock have been reported;
- varied job content and considerable freedom of action: stress is reduced, and the worker's skills are needed;
- easier planning and monitoring of production: each aggregate production insula can be treated as an individual, detached unit.

The main drawback here is the unbalanced utilization of machine capacity. However, the economic effects this has can be alleviated if capacity requirements are geared to ensuring that the most expensive piece of equipment is fully utilized and if one aggregate production insula is allowed to make limited use of another's idle capacities. The higher cost of having a whole team of skilled



1st stage: Part family	Parts with similar manufacturing requirements (grouping parts)
2nd stage: Manufacturing facility	Equipment needed for completely manufacturing a part family (grouping machinery)
3rd stage: Working group	Equally skilled workers cooperating to completely manufacture a part family by appropriate equipment (grouping personnel)
4th stage: Production insula	Integration of design, planning and controlling tasks for complete production of a part family (organizational grouping)

Fig. 5: Principles of group technology

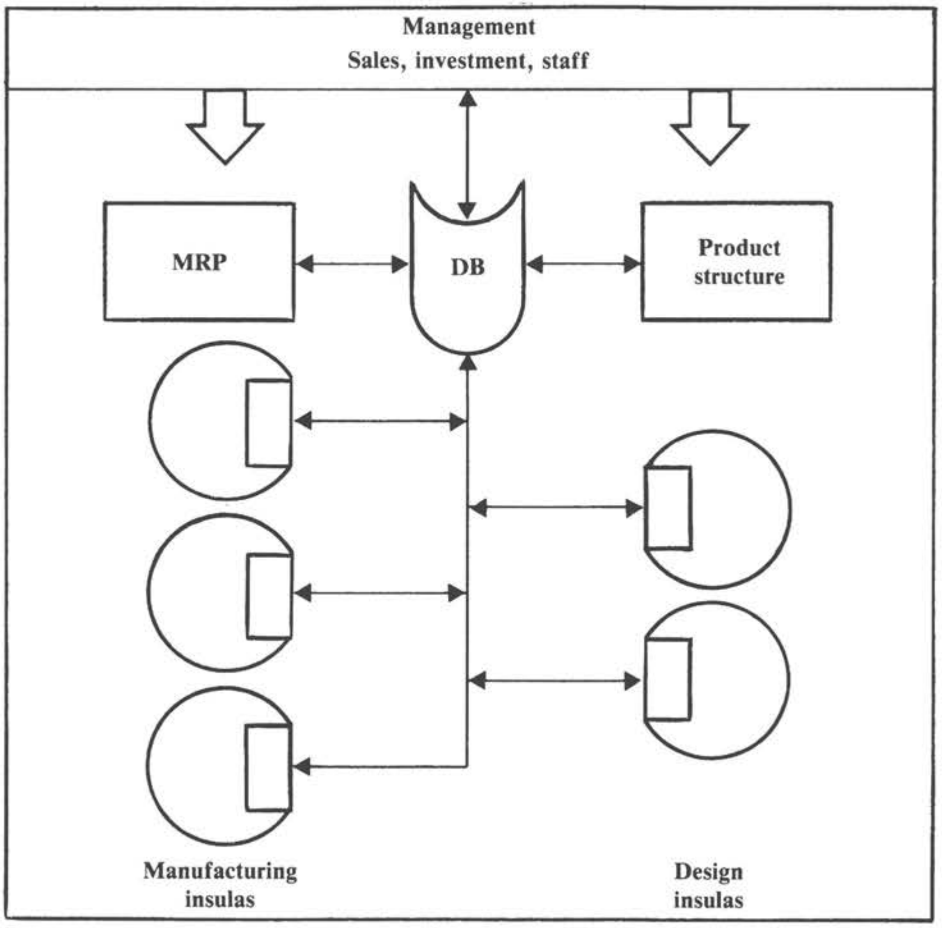


Fig. 6: Integrated group manufacturing

workers rather than a semi-skilled workforce is easily offset by the other benefits of group production. These main advantages are joined by other benefits in the shape of greatly reduced set-up times, improvements throughout the manufacturing process and increased productivity.

In much the same way as they can be applied to the manufacturing process at shop-floor level, where the know-how needed to make machines exists, these organizational principles can be applied in the design office, where the know-how needed to invent machines exists. If the design process is broken down into product families (or their modules), each designer or team of designers can cover the whole range of such tasks as the identification of functional structures and dimensions, calculation, the design of individual parts and geometric modelling. This generally results in the creation of two skill-centred production subsystems assisted locally by computers and linked by electronic data exchange: production and design insulas.

If they are to work efficiently, these largely autonomous subsystems will still need some exchange of data. They must therefore be linked by means of the basic components of CIM architecture, i.e. a joint data bank, a data highway and data exchange interfaces (Fig. 6). However, the anthropocentric approach differs radically from the technocentric approach in the form taken by computer assistance. Instead of concentrating the use and portrayal of as much know-how and as many work sequences as possible in the computer system, the anthropocentric approach uses the computer as a general, topical and consistent information system to carry out routine operations, while the planning of work processes is left to the skills of the workers and designers (who may even use their own tools).

Although this is not the place for a more detailed analysis, both production concepts can be expected to lead to a substantial increase in productivity. There is much to indicate that productivity will rise even faster if the anthropocentric development path is chosen. Paradoxically, the better use production makes of the quality or labour, the smaller the quantity required. This generally implies a significant effect on employment and particularly on the structure of labour markets, principally because the high level of skills needed increases the trend towards segmentation. Combined approaches must therefore be developed at the level of both firms and society (appropriate training for everyone, reduction of working hours, etc.) so that the segmentation of work and the growth of unemployment can be avoided (Brödner, 1985).

Production know-how

Whatever form production may take, one of the worker's characteristics is that he has a picture in his mind of what he is going to do before he actually does it. His changeable behaviour is itself the product of the mental images which he has both of his actions and of their effects on the object he has created.

During his active involvement in his environment the worker perceives these objects and, by handling and using them, learns how they function and takes a given course of action. In short, he comes to understand them. By repeatedly taking the same action in similar situations, he may make reductions from each and recognize the general in the specific. He is thus able to generalize the various courses of action he takes and to objectify his experience in the form of language, tools and machines (Volpert, 1984).

By making a conceptual analysis of his deeds, the worker is able to construct an abstract model of his actions in general that includes the objects and the rules governing changes to them. Machines are therefore nothing other than theory put into practice. However, if he is to make this conversion, the worker must recognize recurring factors in changing situations. If he fails to appreciate the general in the specific, the experience he gains will remain confined to him. This 'suppressed knowledge' (Polanyi, 1966) places a barrier before the formalization of production know-how. Production know-how cannot be released by empirical and theoretical analysis alone: production processes cannot in principle be conceived in every detail.

On the other hand, because of his mental perception in a given situation, the worker is aware of any change in the environment that has developed with him while he has been active in it, and he perceives such changes as a whole, not as elements which first have to be fitted together by some set of

Judgement level	**Sub-levels**	**Possible criteria (examples)**
Personality promotion ↑	• raising the skill • preserving the skill • de-skilling	• margin of action • learning activity required
Lack of impairment ↑	• no impairment • reduced effectiveness • functional disturbance	levels of psychic or physical stress effects (e.g. monotony, overload, saturation, shiftwork)
Lack of damage ↑	health damage • excluded • possible • very likely	• standard values of detrimental environmental influences (noise, lighting, climate, toxic substances) • danger of accident
Practicability	minimum requirements • kept • partially undercut • mostly undercut	• anthropometric standards • sensing capabilities • psychic capabilities

Fig. 7: Hierarchical system of work design criteria

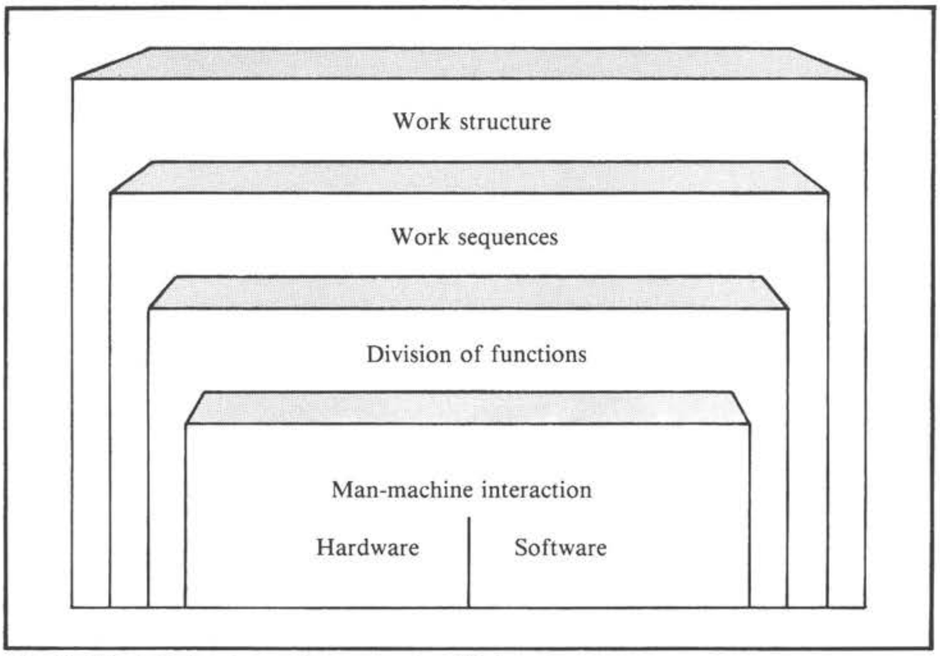


Fig. 8: Work design layers for computer-aided work systems

rules. He therefore knows how to act in an oriented manner, even in an uncertain or unstructured situation. The practical experience he has gained, or his 'suppressed knowledge', which is far more extensive than any formalized knowledge or knowledge governed by rules, forms the basis of the specifically human ability to perceive and evaluate complex situations, to take appropriate decisions and to act accordingly.

While human beings who are not equipped with a particularly impressive capacity for processing information and are unsystematic and inconsistent in their behaviour are none the less able to act creatively even in an unfamiliar environment, machines depend on man-made programmes if they are to change their state and to operate with the aid of data formats, which are consistent and governed by rules. If the opposing attributes of man and machine are to be united to productive effect, a number of basic principles, which correspond to the hierarchical system of criteria governing work design, as shown in Fig. 7, must be observed (Hacker, 1978).

Work design, i.e. determining the division of labour, of functions between man and machine, the modes of interaction between man and machine (see the various levels in Fig. 8), must be such that the worker retains considerable freedom of action in the work situation, so that he can initiate, appraise and decide and his tasks include both the planning and the performance of tasks. In a situation such as this the computer can be used as a tool: its functions and its behaviour must be completely transparent. Above all, its reactions must be self-explanatory and adapted to the actual work situation. For there to be interaction, it is extremely important that the worker should be able to perceive the connection his own intentions or actions and the effects they have.

Accordingly, a suitable user surface is needed for the technical equipment. Interaction between man and machine must therefore be so designed that it is:

- transparent and self-explanatory through the use of direct object manipulation;
- adjustable to many degrees of user experience with the aid of flexible dialoguing procedures;
- reliable through the application of the principle of 'What you see is what you get'.

Correct ergonomic design of terminals and visual display units is also essential. Current CAD/CAM systems do not meet these requirements at all or only to an unsatisfactory degree.

The politics of production

The history of industrial production is also the history of management's manifold attempts to gain control over the production process. At the very beginning of the first industrial revolution, when craftsmen were employed to work under the unified command of an entrepreneur, the work process still followed the pattern to which they were accustomed. As the workers had all the production know-how, the entrepreneur was entirely dependent on their goodwill when it came to producing something of the required quality.

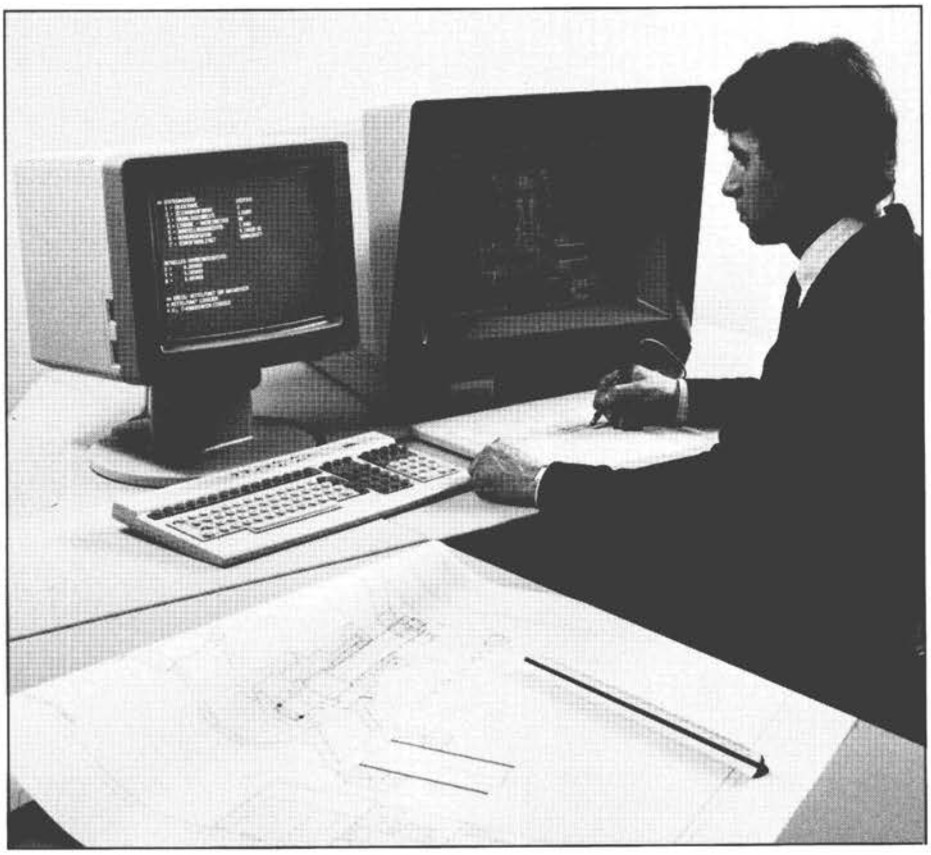
From the entrepreneur's point of view, this situation, which reveals a fundamental problem of capitalist production, was very unsatisfactory. True, employment contracts gave him the right to hire and fire, but this did not determine the actual way in which the work was done or ensure that labour was used productively. As the productive forces, the ability to produce or create something, cannot be separated from the worker, as he and his skills are inseparable, the entrepreneur is forced to cooperate with him. The problem of the politics of production stems from this situation.

The only way the owner could improve his position was to change the production methods. The first major attempt to gain more control over production was the horizontal division of labour proposed by Adam Smith.

In addition to the economic advantages of increased production at lower costs, which Smith saw as a basis for the 'wealth of nations', the specialization of workers in certain aspects of the work process resulted in their eventually losing most of their production know-how to the entrepreneur, who was then able to determine the basic structure of manufacturing himself (Marglin, 1977).

In general, the horizontal division of labour also formed the basis for the introduction of machines into the manufacturing process. The repetitive operations which the workers were required to carry out were easily analysed and conceptually modelled and so eventually transferred to machines. Machines not only increased output but also helped to solve the problem of how to improve control over production. 'One great advantage which we may derive from machinery is from the check which it affords against the inattention, the idleness, or the dishonesty of human agents' (Babbage, 1835).

Despite the horizontal division of labour and the limited use of machines, control over production was still deficient because



the workers were able to act autonomously within the division of labour. It was here that Taylor appeared on the scene with his 'Principles of scientific management'. A careful empirical analysis of work operations and metalworking had enabled him to objectify essential aspects of production know-how and so to separate planning from implementing tasks. Management was now able to plan work processes independently of the workers and to prescribe how and in what time they were to perform their tasks. The more recent introduction of semi-automatic machines and computer systems into manufacturing (Fordism in mass production, NC technology in small-batch production, CAD/CAM systems) has concentrated even more of the power to control production in the hands of the managers.

This development had its price, however. The less autonomy the worker enjoys and and the less experience he has of production, the more inflexible manufacturing processes become. This is most apparent in mass production, which was designed explicitly for the manufacture of products with few variations. But the same is also true of small-batch production, where Taylor's principles could be applied only in part and resulted in the unfavourable structures discussed above (jobshop production by highly skilled workers despite central planning). Neither type of manufacturing process, inflexible mass production and hybrid small-batch production, which is partly Taylorized and partly skill-based, meets the new requirements of global competition. A high level of flexibility in manufacturing is incompatible with the de-skilling of the workers and the restriction of their autonomy. New production concepts, with changed politics of production and alternative forms of control over production, are therefore needed.

The principles of group technology and of autonomous working groups form one such production concept. The autonomy of the production and design insulas, however, can be developed only within the limits imposed by management's fear of losing control over production as a whole. Control takes a different form, of course. In the technocentric approach it was exercised by means of formalized know-how, the detailed working instructions derived from it and the machine system. Now it is exercised by means of computer-aided, central planning, the supervision of overall production, although local planning and implementation are given far more scope, and a policy based on performance and a challenge to the workers' competence, autonomy and sense of responsibility (Kern and Schumann, 1984). The motto now is 'Control autonomy rather than destroying independence.'

Conclusion: the superior option

To summarize all these considerations, we clearly have a choice to make. There are various options for computer integrated manufacturing, and different economic benefits are, of course, to be derived from them.

In view of the problems posed by the technocentric development path, the anthropocentric approach is obviously superior, in both economic and human terms, and especially under unsettled market conditions. It reduces processing times dramatically (with enormous potential for saving costs and gaining market power), and it is less capital-intensive, particularly on the software side, because existing skills are essentially retained and not replaced with programmes that entail high costs. It is this that makes production very flexible, especially as changes to orders or processes can be contemplated without prior modelling. Working conditions provide considerable freedom of action and allow skills to grow, thus preserving the capacity for innovation. As the anthropocentric development path can be taken step by step, it is open even to smaller firms.

However, strong forces of inertia are obstructing the rapid spread of the anthropocentric approach. They stem from a firm's hardware, software and social system and from the prevailing ideology. While inertia seems weakest in the hardware field, fundamental changes to software are needed. The highest barriers are formed by the social systems and ideology. As the transition to group production has a pronounced effect on social positions and relations, it can be accomplished only on the basis of a participatory strategy of consensus. If a strategy of this kind is to be established, the dominant philosophy, which maintains that production can be improved only by replacing human skills with man-made machines, must first be overcome.

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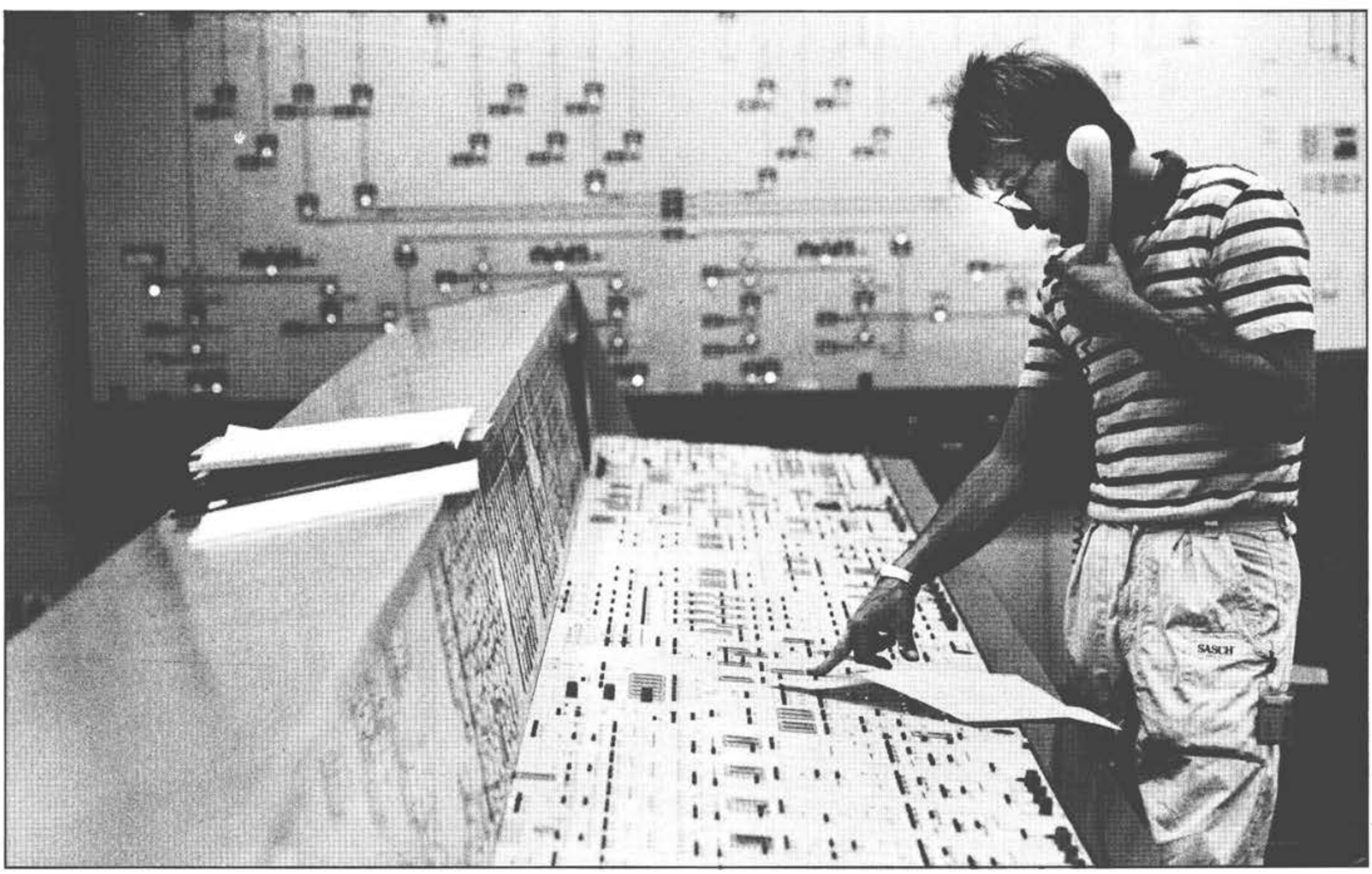


Manfred Linke/LAIF

European futures in science and technology: an introduction to FAST

Ricardo Petrella

The changes underway, partly caused by scientific and technical progress, make it difficult to obtain a clear picture of what European societies could and should become in 15 to 20 years time. Consequently, there is an ever-present need for European forecasting in science and technology to clarify and give a common purpose to Europe's long-term technical and socioeconomic development. This is all the more important today when Europe is suffering from the lack of any integrated view of national futures and when science and technology are confronted on a planetary scale with new industrial, military and political challenges.

Objectives and functions of FAST

The FAST programme, launched by the European Communities in 1979, is a tool for developing long-term directions for R&D at Community level and contributing to the definition of new strategic priorities for Community policies associated with scientific and technological developments.

RICARDO PETRELLA, of Italian nationality, born in 1941, Head of FAST (Forecasting and assessment in the field of science and technology) programme at the Commission of the European Communities since 1978.

Previously, he was Director of the European Research Centre in Social Sciences in Vienna from 1970 to 1976.

He is the author and editor of several books on regional development, industrial location and technological policy.

FAST has two main tasks:

- a research task: the analysis of scientific and technical changes in its many dimensions – economic, social and political.

- an organizational task: the strengthening of the basis of current European forecasting and assessment thinking by encouraging the creation of *ad hoc* co-operative networks between researchers, civil servants, industrialists and concerned social groups on a European scale.

The main orientation of the FAST approach is towards the social and individual changes which are being brought about by the application of the new knowledge and technology. A technology driven analytical approach (technological development first, then consideration of its impact on the economy and society) is not the most pertinent and useful approach to serve the interests of policy-makers, who expect to derive from technology assessment and forecasting a better understanding of on-going and potential complex societal changes and clear indications for options and strategic choices.

FAST II (1979 – 83)

Societal analysis and forecasting of technological change may seem a circuitous way of identifying long-term R&D priorities, but it is unavoidable. That was the basis of the FAST I approach.[1] Its work, backed up by the studies conducted by some 50 European centres,[2] showed that the Community R&D policy inspired by the crises of the 1970s did not sufficiently anticipate the turn-of-the century problems. It was therefore necessary to extend and change the emphasis of the R&D activities in the light of five major guidelines:[3]

- to sustain and stimulate the consolidation and renewal of the European industrial base around two poles: the 'agro-chemo-energy' complex and the 'space-electronics' complex;

- to contribute to the design and development of the infrastructures of the next 30 years for the new services (in particular telecommunications);

- to accompany the transformation of employment and to facilitate the establishment of new man-machine relationships;

- to inspire and stimulate the science and technology needed for the solution of certain major problems of third world countries and the development of their indigenous scientific and technological potential; and

■ to provide the Community with the necessary and essential knowledge to facilitate the joint mastery of technological change.

The FAST approach also proved fruitful in practical terms – the results of the approach have given rise to new joint ventures. For example, they have been used to prepare a Community biotechnology policy; they have provided initial concepts for the Esprit programme; they have provoked a debate on the role of technological innovation in the phenomenon of 'bogged-down growth'. In a more limited area they have, for example, led to national programmes in the areas of chemical R&D and instrumentation technologies for the environment, etc.

Research portfolio (1984 – 87)

According to our basic approach, we considered that instead of designing our research topics primarily around the major technological 'families' (microelectronics, telecommunications, materials, biotechnology, energy . . .), it was more fruitful to engineer our 'work programme' around some major areas of application and diffusion of new science and technology, which are clearly of vital importance for the economic growth and social development of the European countries.

This is why FAST II's main areas of investigation are:

■ technology-work-employment relations (TWE programme);

■ Services and technological change (SERV programme);

■ new strategic industrial system of communications (COM programme);

■ future of the food system (ALIM programme): and

■ integrated developments of renewable natural resources (RES programme). (See Figure)

Alongside these five problem areas, some horizontal activities (e.g. cognitive sciences) are also being undertaken to ensure that the results of the work are consistent and properly integrated.

Research tools and organization

How does FAST operate?

In order to carry out its research activities and fulfill its basic tasks, FAST uses three 'instruments':

■ In-house research

carried out by members of the FAST team and by scientific fellows. The 'fellows' are seconded to the FAST team by national organizations for a limited period (12 – 24 months) to work on a well specified task.

■ External, contract-based research

carried out by European teams selected from the Community member countries. A few exceptions arise – external researchers and also contractors have been selected following an open call for tenders.

■ Research via networks

involving several researchers and research centres coordinated by a member of the FAST team, a fellow, or a national unit of the FAST 12 + 1 Network.

Initial pointers for research results

At the end of 1986 the FAST team commenced work on:

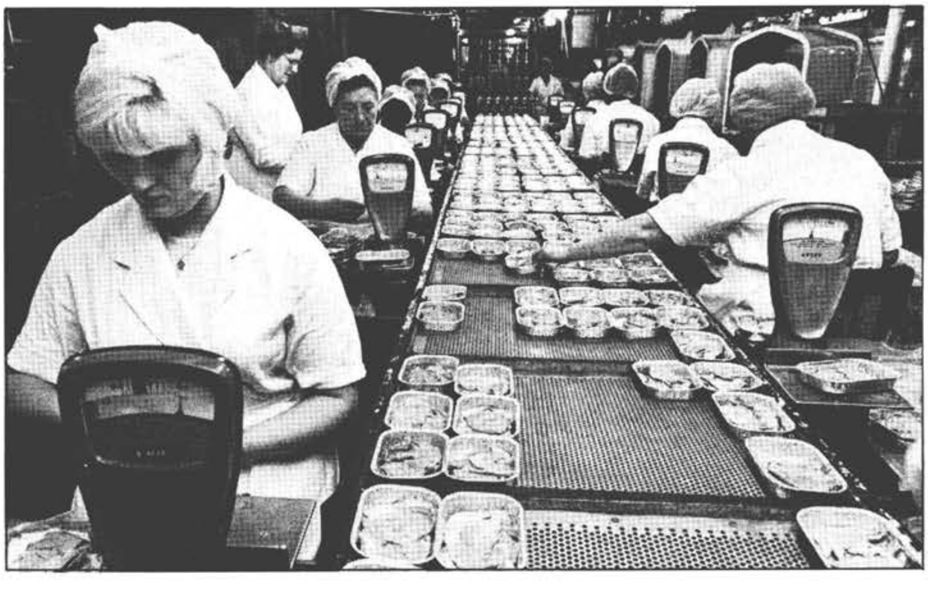
■ the synthesis of the results of the individual projects presented in more than 70 research reports. The second final FAST report will be submitted to the Commission of the European Communities in April-May 1987.

■ the elaboration of the portfolio of proposals for new points for Community action in R&D and technological development and related structural common policies.

It is therefore not possible in this paper to go much beyond some preliminary points on tendencies, problems and perspectives in each of the five major areas of FAST investigations.

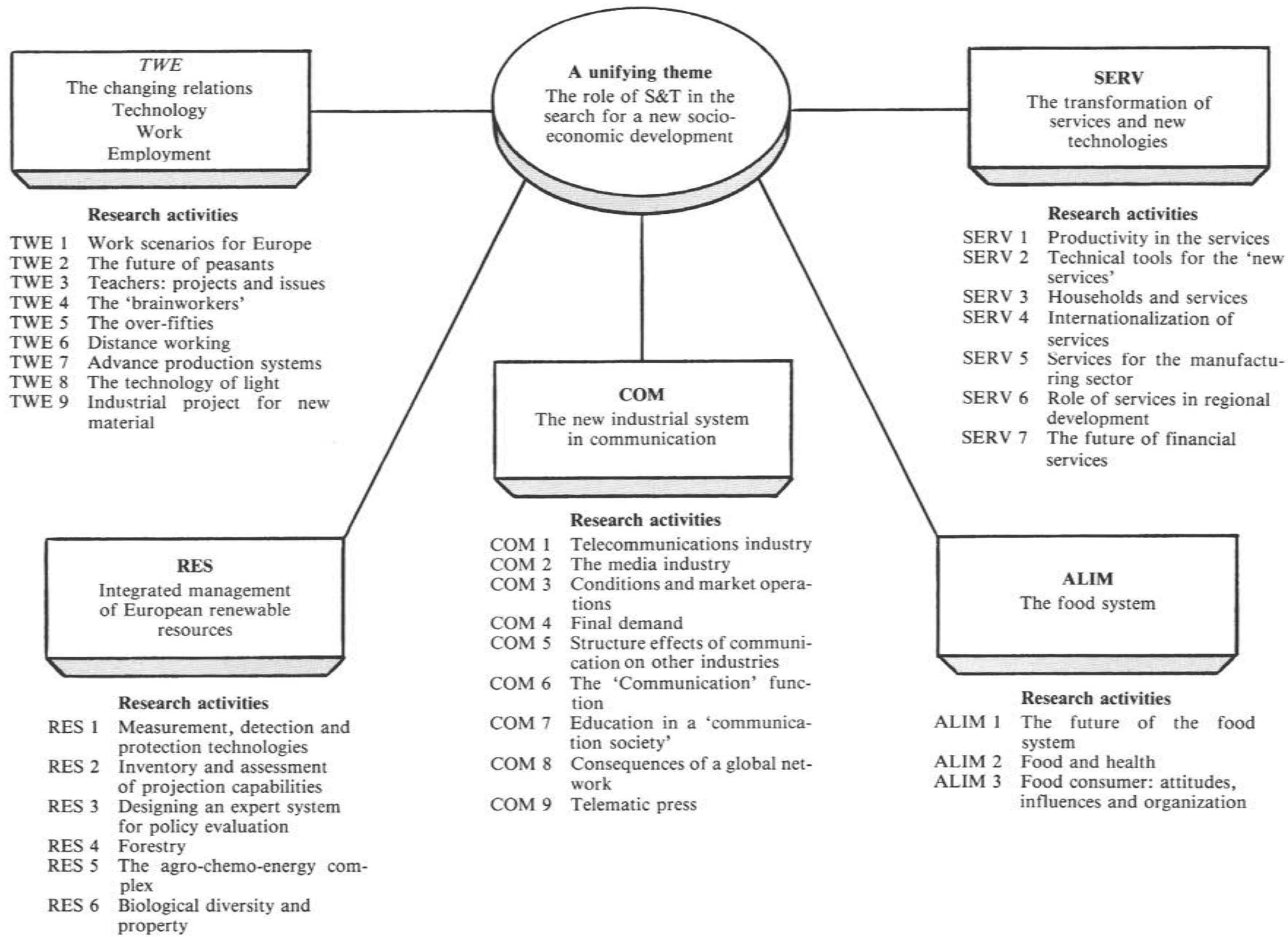
Relations between technology, work and employment (TWE)

Prudence is required when analysing the impact of new technologies on the volume of employment. Technology is only one factor among others (demographic evolution, national and international economic context, public financing, the strategies of the actors involved, the relative economic strengths of competing countries and industries . . .). In addition, it is always difficult, both



Chris Davies/NETWORK

FAST research portfolio – major areas and specific research activities



Ebeler/STERN

methodologically, and through the lack of adequate data, to reconcile the results of global analyses (at the level of the national economy, for instance) with specific case studies. In this context, the FAST research on 'Macro-economics and technology' has once more underlined the usefulness and limits of existing economic theories with their corresponding econometric models.

A number of interesting points, however, can be singled out:[4]

■ The new technologies have still not reached the level of diffusion predicted at the beginning of the 1970s. Since then, the quantitative impact on new technologies on employment has not been as important as was anticipated. This situation should change in years to come to the extent that informatics also affect small and medium firms as well as liberal professions.

■ Global studies tend to emphasize the positive effects of new technologies on the volume of employment even in the short term as a result of the secondary and indirect impact of technological change.

■ On the other hand, the majority of case studies point to a negative direct short-term effect on employment.

■ Employment creation is more significant when new technologies are used in products rather than production processes and when they involve new uses rather than the improvement of existing ones.

As regards the qualitative implications and consequences for work, the principal aspect which seems to emerge from the growing complexity and interaction between tools and technical systems is the transformation of man-machine relations and the need to identify the new scientific, technical, economic, organizational and ergonomic factors.[5]

Taken as a whole, the work under way in the sub-programme 'Technology, work and employment' (but also some of the research in SERV and COM) emphasizes the importance assumed by:

■ programming and maintenance of new tools and technical systems in the factory and office;

■ study of cognitive aspects in man-machine interaction;

■ mastering of adaptation processes and the transformation in qualification and the acquisition of new skills which demand the elaboration of appropriate training policies at European level (including the training of the educators), and in particular effective policies for social experimenting;

■ research on polyfunctionality and flexibility in work organization; and

■ the general problem of a 'human resources policy' both at shop-floor and office level.

Attention has also to be paid to specific categories (the over 50s, for example), new patterns of work (distance working, in particular), certain groups of technologies (new materials and their impact on skills), certain industrial branches (tool machines) and certain types of enterprise (in connection with the transnationalization of economic activities).

Service activities and new technologies (SERV)

The following preliminary observations may be drawn from the work of 20 associated research teams under contract, although the diversity of the socioeconomic context of the European countries make attempts at generalization rather delicate.

The development of service activities is continuing and is spreading. This phe-

Manfred VOLLMER

nomenon is starting to be taken into account in the strategies of economic and political decision-makers (as can be seen from the negotiations from the new round of GATT talks) but only in a fragmentary and rather inconsistent manner. There is a disturbing lack of proportion between the economic role of services and the attention given them by decision-makers in both public and private sectors, in particular as regards economic adjustment and industrial redeployment strategies and policies for European integration.

In international competition, services for firms and for manufacturing are playing an increasingly decisive role and are becoming a factor affecting the competitiveness of industry in the same way as wage costs because they make a direct contribution to the viability and efficiency of the firm and to its ability to adapt and innovate. They often incorporate a great deal of high technology and are frequently 'tradeable'.

The work in progress shows that Europe has certain strengths and weaknesses. In a fairly large majority of cases, European firms providing services to companies are among the world leaders and their financial situation is sound. But technological leadership is rarely acquired by Europeans themselves, which puts European firms in a situation of dependence, especially regarding innovation (new services based on new technologies).

With certain exceptions, the European market remains often very protected and foreign penetration is low; this probably accounts for the wide variety of attitudes adopted by service companies to the liberalization of trade in services. The material and intangible infrastructure needed for the development of advanced services is starting to be established in different European countries. However, their development at Community level for the moment remains fragmentary, with a low level of integration (barriers of various kinds, lack of common standards, etc.).

Again, in the international field, the production and marketing of services (or complex combinations of products and services in close association) depend greatly on world networks – telecommunications systems, information systems and data bases, financial circuits, sales networks, etc. The real issue in international trade, therefore, is no longer located only at the traditional level of barriers and restrictions in the narrow sense to trade of products and service. It now applies more and more to questions of access to these networks.

The new technologies, especially information and communications, hold out prospects in the medium and long term of major and even radical changes in the production, distribution and consumption of services. The fields most affected are those activities tied to the process of the 'dematerialization' of productive activities (industrial services for automatized production units: maintenance and servicing, training, advanced engineering). In the case of traditional tertiary activities, administrative services are equally involved (information processing), education, financial services, radio and television and the press, and to a lesser extent (at least for the moment) commerce and health. It would seem that as in the manufacturing industry, process innovations will be much more developed than product innovations because the latter, to an even greater extent than in the secondary sector, require highly qualified staff to implement them. The social consequences of these tendencies will be of considerable importance.

First, at the level of employment, it is not at all clear whether services will take up the slack of the manufacturing sector. New employment created in rapidly growing tertiary sectors (professional services for firms, certain services connected to health, well-being and leisure, for example) risks being counterbalanced by significant reductions deriving particularly from the priority often given to process innovation (office technology, automation and administrative tasks, the incorporation of services into the product).

In addition, 'new services' risk seeing their development held back by a lack of qualified personnel. At job level, important transformations in the content of tasks are to be expected, leading to the need for new qualifications, skills and technical capacities. One can foresee that supply will be less than demand both in quantity and quality.

And finally, as regards impact at the individual level, a number of studies in progress do not point to very optimistic conclusions. Current tendencies to rationalization and to the 'industrialization' of services, risk leading to a deteroration in quality and variety of services for large groups of the population and to an increased duality within society between families and firms which will have a sufficient technological level (in terms of equipment and technical culture) to benefit from the new services and those which have not.

The new strategic industrial system of communication (COM)

The technological trend in networks is towards integration, but also towards flexibility, which indicates that there is likely to be a strong impact on users. For example, portability appears to be an important aspect of this flexibility and the idea that each of us will carry with us a communication gadget like a sort of artifical aid is gaining ground. The requirement for network flexibility is a real challenge to innovation (miniaturization, self-contained equipment, integration of radio transmission and cabled networks). It applies on all fronts (terminals, transmission, switching).

The media explosion and the diversity of national situations tend to obscure the context in which the actors concerned have to take decisions. Technical progress and regulatory requirements are not always in step and this has caused some strategies to misfire (understanding investment in the cable networks in the UK, the difficulties of launching 'Canal Plus'). It is fair to say that the situation of the media is extremely chaotic, largely because of the failure of authorities to take decisions. At the same time, research shows the importance of the way in which the media are financed: depending on whether their revenue comes from advertising, a licence fee, a subscription of an hourly price, the development of programmes may be very different.

The nature of final demand is still uncertain. It is difficult to analyse since the benefit of any system to consumers is directly dependent on the use of the same system by others. What use is electronic mail until a critical mass of the population has access to it? What good is 'home shopping' if only one shop in ten is equipped for it? Consequently the validity of social experiments depends largely on how widely the innovation under test is available in the surrounding social fabric, but it is impossible systematically to carry out full-scale experiments to check whether the equipment and services proposed genuinely satisfy requirements.

Demand from companies is extremely strong and relates both to IT products and to a legal framework allowing them recourse to the courts to settle conflicts arising from IT transactions. In fact, agreements between partners are always possible and there is no need to wait until the legislator is ready to act before concluding them. It is clear that the lack of a regulatory and legal framework has an inhibiting effect on IT transactions because in the event of disputes, partners are not in a position to produce proof and must therefore take precautions for their own security.

All these factors show, each in its own way, that the development of the communication function inevitably involves the public sector. It is up to public authorities to introduce greater transparency with regard to the development of the communications function. Its failure to do this would give an advantage to those companies whose strategy is designed outside Europe and is not necessarily compatible with Europe's long-term interests. It would also come down to penalizing a European private sector unable to devise its own long-term strategy for lack of any 'institutional security'.

The right level for this approach is obviously the Community level since it is quite clear that, for example, as far as satellite TV, commercial transactions, and the terminal market are concerned, national frontiers are outmoded and ineffective. For communication, the public sector must therefore organize itself at Community level. In addition, the approach must be integrated: it is necessary to coordinate network and terminal development; it is essential to coordinate support for R&D and the production of the regulatory framework allowing new uses to develop; it is essential to coordinate the programme industry and the granting of licences.

The future of the food system (ALIM)

Relative household expenditure on food is down, but trends in individual consumption patterns are difficult to identify because of lack of disaggregated data on consumption (in and outside the house) by individuals in different regions and with different socio-economic characteristics.

Changes occurring in our modern industrial societies around themes linked to health also affect attitudes towards food. Parallel to the development of jogging, fitness centres, etc., more and more consumers are becoming interested in health aspects of their food consumption pattern. In spite of doubts about the real impact of food on health, the tendency towards 'more healthy' habits is increasing. Different actors in the food chain, manufacturers but mainly distributors, have already integrated this fact into their development strategy.

In European countries, as in the majority of modern industrial societies, the main problems of health linked to nutrition are the result of excessive consumption or badly balanced diets. Under these conditions, it is essential that those involved in nutrition and health problems arm themselves with appropriate tools to enhance the public's knowledge of nutrition and its ability to act on that knowledge. The development of education and information programmes on food in the school curriculum or through the media, nutritional labelling, etc., are important examples.

In addition to nutrition, other health-related matters of concern include the contamination of food by microbes, heavy metals, pesticide residues, hormone residues, food additives, etc. Evidence about these is being collected.

The new technologies applicable to food, especially in the field of biotechnology, are not confined within agro-food industries. This makes the agro-food field accessible to firms from other sectors, including the chemical, petrochemical and pharmaceutical sectors.

The result could be a tendency for food companies to become integrated with companies in other sectors, or, more radically, a trend towards the taking over of certain food production operations by 'newcomers', who, with the backing of a sound financial position and proven industrial management know-how, could well become leaders in various subsectors. Thus, food production could to some extent slip out of the hands of the companies in the industry, the most vulnerable being, perhaps, the smaller firms.

The food manufacturing industry is faced with a powerful downstream sector, the distributive trade, which is concentrated and organized. Many food manufacturers try to free themselves from the constraints this imposes by combining and endeavouring to develop a more aggressive marketing policy.

From the upstream point of view, the recent discussions held in the Commission on the future of the common agricultural policy (CAP) have shown that the CAP must gradually move towards a better matching of supply and demand within the Community and towards giving proper consideration to new industrial development policies made possible by scientific and technological progress. This development, which is gradually taking shape, must bear in mind the many possible uses of agricultural land and products and the necessary grading of agricultural raw materials in the light of the processing industries' objectives (process automation, improvement of end product quality, development of new products, etc.).

Finally, at world level the trends are extremely complex to assess. The combined effects of plant and enzyme technology may well lead to greater self sufficiency in the provision of foodstuffs. While trade in raw materials seems likely to suffer, the trend to higher value-added food exports by third world countries could be stimulated. By contrast, the participation of industrialized countries in world food trade should shift increasingly in the direction of technology transfers.

Integrated development of renewable natural resources (RES)

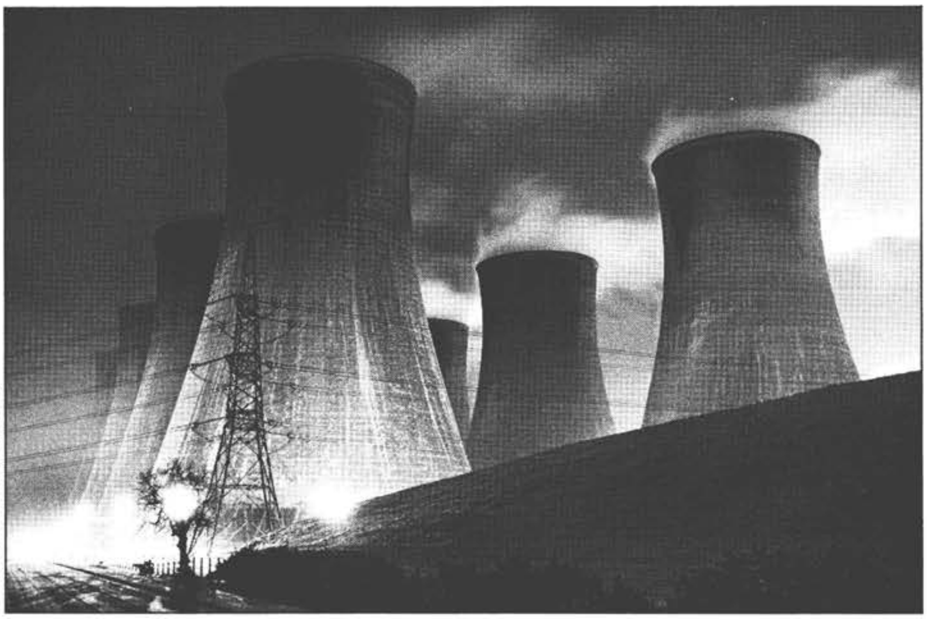
These initial research activities have tried to specify the principle lines of development leading to a revision of our practice as regards the management and exploitation of natural resources and to an integration of policies dealing with agriculture, industry, energy, forestry, the environment, fishing, etc. Among these, the following elements would seem worthy of note:

■ Improvement of our basic knowledge – an approach based on complexity

The development of our knowledge, in particular in thermodynamics of open systems and in life sciences (physiology and ecology for example) combined with the development of models, allows us a better understanding of the complexity of the mechanisms and regulations according to which all living systems (including human societies) make use of the constituents of their environment to develop, maintain and reproduce their structures.

In particular, there is a better recognition of the importance which should be given to relations established between different components of the natural milieu, through the biogeochemical cycles among others, for the evaluation of long-term development strategies for renewable natural resources. This reinforces the relevance of the concept of 'integrated management' of renewable natural resources.

Our greater understanding of the dynamic and complexity of the living world should in addition lead us to intervene in the procedures for optimizing the economic development of factors such as: the rhythm of reconstitution of natural resources, the 'resilience of ecosystems', genetic variability, etc.[6]



John Sturrock/NETWORK

■ Increase in competition between the different branches using the product of photosynthesis

Progress in molecular biology, chemical and enzymatic engineering, together with process engineering, provides us with a new arsenal of mechanisms for redirecting the products of photosynthesis for our own purposes. The charateristic features of this evolution in science and technology are defined on the one hand by a more precise mastery of the processes of reproduction and development of living organisms (one can envisage their tailoring to measure in the function of specific uses), and on the other hand by equally elaborate raw material transformation processes (in particular fractioning and recombination).

Such development will promote the interpenetration of different branches using the products of photosynthesis (agrofood, energy, chemicals, paper, construction) and may lead to competition for the same type of production (cereals, for example). It will be necessary to see that production structures adapt to this development. New relations will have to be established between the different agents within a particular branch – one can think, for instance, of the development within the rural milieu of centres for primary transformation of agricultural raw materials, whose vocation will be to furnish primary products on demand for the chemicals, energy and agrofood industries.

■ The need for land management in line with different activities

The transformation of the productive structure also redefines lifestyles and the location of different activities. The future will be marked by a competition for space between leisure (tourism, sport), residential areas and productive activities.

It is necessary to ensure that different land uses are harmonized and do not enter into conflict. We must also be prepared to preserve certain natural habitats, which are essential, particularly for the preservation of biological diversity.

These first studies have also helped towards a better identification of the context determining the implementation of long-term development plans for the Community's renewable natural resources.

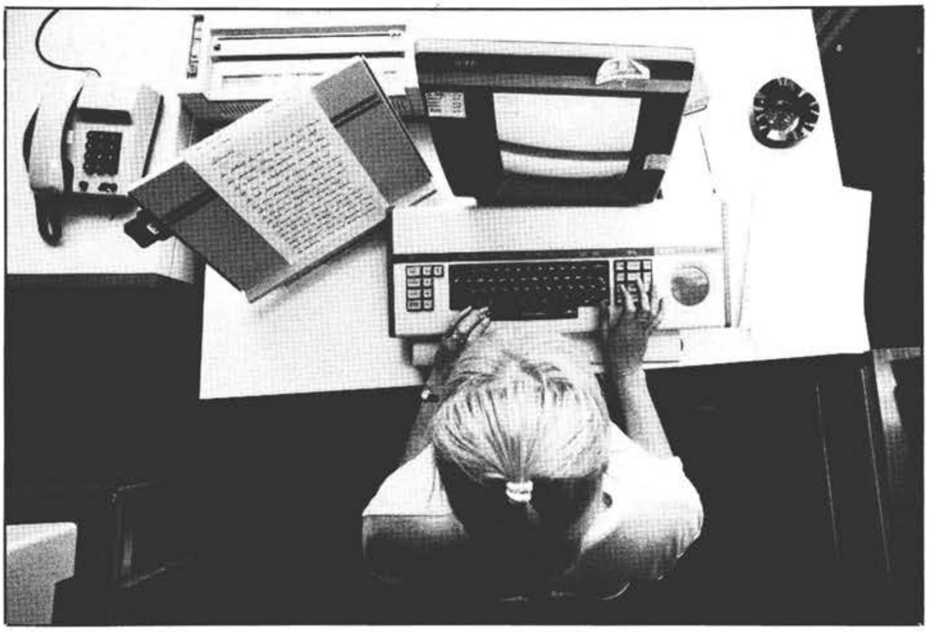
■ Growth of international competition

Agronomic progress is not limited to industrialized countries. The adaptation of industrial crops to critical natural conditions makes comparative advantages based on soil and climate less decisive, and various developing countries today achieve productivity levels which allow them to compete with industrialized countries, both in the area of agrofood production and outlets opened up by other sectors. Competition on a world scale therefore is aggravated, even within the same branch. Such competition may well increase in the future, given the important productivity reserves still existing in various developing countries.

■ The world dimension and the development of the geopolitical context

Europe's dependence in the case of wood and derived products, the extreme interdependence of agriculture at a world level, and the growing disequilibrium between supply and demand for foodstuffs are widely acknowledged.

The international dimension of environmental problems is also widely recognized: acid rain, increase in the atmosphere's CO_2 content. In addition, we are currently witnessing an aggravation of relations, particularly between rich and poor countries – for access to, as yet, little or unexplored resources: tropical forests, the seas and oceans. All these factors are sufficient to demonstrate the international dimension of policies for the development of natural resources and the importance which should be accorded to the implementation of appropriate measures for coordinated action at this level.



Günay Vlutunçok/LAIF

Enlargement to the '12'

Enlargement of the Community to include Spain and Portugal shifts Europe's centre of gravity to the south. This makes the resighting of priorities all the more urgent for the definition of intervention in the questions of agricultural policy, forestry . . . together with scientific and technological policy.

Concertation structures

There is an evident lack of coordination between the different interested parties in the development of renewable natural resources: public authorities, researchers, farmers, industrialists, Each acts on the basis of its own particular logic without taking into account the possible convergence between the different activities connected with resource development and new industrial policies made possible by the progress of science and technology.

In the area of modelling, for example, European expertise is certainly significant, but it is fragmented and dispersed and advances are disconnected. In addition, with the exception of specific applications (climatology, for example) the models are little exploited as aids to decision-making. There is much to gain, therefore from improvising interaction at all levels between users and producers of such models.

For the Community, the question is particularly that of reinforcing dialogue within existing structures, both at the level of scientific and technological cooperation, and for the integration of key elements of different policies and activities of Member States as regards agriculture, sylviculture, the environment, chemicals, energy, etc.

Adapting the relevant common policy instruments

The instruments of relevant Community policies (CAP, environment, energy, R & D, etc.) are perhaps not well adapted to the needs of renewal which are on the agenda. They are often oriented to specific objectives of a particular sector, and do not favour an integrated approach which would allow, for example, for the conciliation of certain objectives for the preservation of the environment with the imperatives of industrial competitiveness. In addition, the panoply of existing measures are not sufficent to confront certain problems such as training and information in the rural context, assistance and follow-up of reconversion projects.

The cooperation 'system'

As the current scientific and technological situation shows, European cooperation is difficult to achieve. It is not as intense and extensive as one may be led to believe, although certain recent initiatives, particularly on the part of business, constitute promising indications of a will to correct current practice.

Under these conditions, forward thinking on the role of science and technology as strategic factors in the common development of European societies remains weak, vulnerable and inadequate. That is why FAST, in accordance with its remit, had endeavourad to evolve a European concept and practice of forward research by promoting the establishment of a European cooperation system.

Two years ago a leading European daily *(Le Monde)* wrote in an article on the results of FAST I 'European forecasting is born'. Today, the FAST European system of cooperation currently involves, in varying degrees, several hundred people (and institutions) not only from the scientific and academic world, but also from industry, labour organizations and government circles. Admittedly, there are problems, inadequacies and short-comings. It is no easy task to encourage cooperation, especially as it is often an expensive business and the most profitable results are not perceptible for a long time.

Nevertheless, the FAST network is clearly performing a dual function. It is acting as a catalyst by concentrating European thinking on the fields selected for the programme. One of the most recent examples is the report submitted by the National Economic Foundation to the Technology and Resource Development Commission in the Netherlands which suggests launching a national research programme on services based on the subjects selected for the FAST programme.

It also performs the task of integrating FAST work with activities in the Member States by encouraging the establishment of close links between joint research at European level and national research. The most striking example is the link established in Belgium between FAST research and national research projects backing up the FAST programme on the same topics and bringing together about a hundred Belgian research teams. Mention may also be made of the links between FAST and PIRTTEM (an interdisciplinary programme of research on technology, work, employment and lifestyles) in France or between the work on the national technology and society programme in Denmark and a number of FAST research activities.

Obviously, there is still a lot to do. Progress will depend above all on the willingness of individuals and institutions to commit themselves to the system of cooperation and, to a lesser extent, on financial resources. The development of a European school of thought for forecasting must occur around future projects of common interest, determined on a cooperative basis. In this way and on a modest scale, such a cooperative system can contribute to the development of long-term initiative capacities for a more autonomous Europe.

It is my hope that the European Congress of Technology Assessment, organized jointly by the Dutch Ministry of Education and Science and the FAST programme, and which envisages the participation of more than 200 European practitioners and users of TA, will be an important milestone in the formulation of the European cooperation system.

[1] Today, this principle is increasingly prompting national authorities to take measures in this field. Examples include the campaign launched in the FR of Germany by the Federal Ministry of Research and Technology on 'Sozialwissenschaftliche Technikforschung', the new five-year research programme entitled 'The context of change' of the Economic and Social Research Council in the UK and the major programme recently approved in Denmark on technology and society.

[2] This work, conducted around three priority themes in the programme (work and employment, the information society, biotechology and society), has yielded around 100 research reports distributed through the scientific community and still in wide demand.

[3] See the final report on FAST I, *Eurofutures, the challenges of innovation* (Also available in Italian, French and German).

[4] On the basis of 'in-house' work by the FAST team, particularly with regard to the research 'Scenarios for Work in Europe' and the drawing up of a strategic dossier on 'man-machine' relations. We would also refer to other recent studies dedicated to this question, C. FREEMAN, L. SOETE: Information technology and employment – An assessment (Paris, IBM Europe, June 1985); W. FRIEDRICH, G. RONNING: Arbeitsmarktwirkungen moderner Technologien, 2 vols. (ISG Köln/Konstanz, April 1985); and Information technology and the organization, a Policy Studies Institute study within the PANTS project, London, June 1985.

[5] Interesting analyses on this question are to be found in some of the research reports presented at the FAST conference, 'The press and new technologies – the challenge of a new knowledge' (Brussels, 7–9 November, 1985) and in the January 1984 conference on the relationships between technology, work and employment organized by FAST jointly with DG V, CEDEFOP and the European Foundation in Dublin.

[6] RENÉ PASSET 'L'économie: des choses mortes au vivant', Encyclopédia Universalis, 1985.

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The following pages contain bibliographical references selected by CEDEFOP's Documentary Information Network referring to the theme of the Bulletin.

By:

CEDEFOP

EUROPEAN COMMUNITIES
INTERNATIONAL ORGANIZATION

Martina Ní Cheallaigh
Librarian
CEDEFOP

Introduction of artificial vision in manufacturing and inspection work and its training implications

A workshop meeting, 6 and 7 November 1985.
CEDEFOP (European Centre for the Development of Vocational Training).
Luxembourg: Office for Official Publications of the EC, 1986, 104pp. Languages: DE, EN, FR, IT.
ISBN 92-825-6379-0

Robotics. Automation. Production. Industry. Training needs. Planning of training. Supervisors. Supervisory training. Maintenance and repair. Engineers. Job requirements. Training systems. Case studies. Automobile industry. Conference reports. FR of Germany. United Kingdom. Italy.

The study was commissioned on the basis that artificial vision systems appear to be next in line among high technology topics to have an impact on manufacturing processes. Therefore, vision systems require a study to assess the likely magnitude of their adoption and the implications of this on patterns in vocational training over the next five years. The strands contained in this report are: the economic background that underpins the expected growth of this field; the development of the vision product itself; the user's perception of the strategic advantage that vision might offer and the implications of this on manpower needs.

Social Europe

New technology and social change – manufacturing automation

Commission of the European Communities – Directorate-General for Employment, Social Affairs and Education (DG V)

Social Europe Supplement 1/86, 149pp.
Languages: DE, EN, FR.
ISBN 92-825-5989-0

Technology. Industry. Enterprises. Automation. Computer applications. Social change. Work organization. Conditions of employment. Employment situation. Training needs. Government policy. Social partners. Reports. EEC countries.

The Commission of the European Communities recently analysed the situation and future of advanced manufacturing equipment in the Member States, with the aim of identifying the need for equipment standardization, etc. The first article presented here outlines the main conclusions of the analysis, with regard not only to the industrial aspects, but also to the employment implications.

Other articles look at the situation, and more specifically at the social implications, from the point of view of each Member State. They present a brief description of the diffusion of the technology; give account of studies carried out in each country on the effects on employment and work organization; outline the main policy measures addressed to the sector, and the position of the two sides of industry.

Bertrand, O.; Noyelle, Th.

The evolution of new technology, work and skills in the service sector

Organization for Economic Cooperation and Development (OECD) Paris/ OECD, 1986, 81pp.

Services. Technological change. Retail trade. Financing. Telecommunications industry. Work organization. Non-manual workers. Clerical workers. Engineers. Draftsmen. Managers. Skills. Job content. Manpower needs. OECD countries.

Within the Centre for Educational Research and Innovation (CERI) project 'Changes in work patterns and their educational implications' a number of research studies of the development and use of human resources, with particular focus on skill formation, in the context of technological change and industrial restructuring have already been completed. Initially these were restricted to five large enterprises in the automobile industry. In the course of these studies the need became apparent to extend the enquiry into the tertiary sector to find out how white-collar workers have been affected by the latest developments in computerization and how current changes there influence work organization, personnel training and skills.

This study attempts to do this, making use of the considerable body of research that has been done recently or is now in progress in a variety of OECD member countries, and drawing on expert advice in a number of them.

Information Sources

Rauner, Felix

Women study microcomputer technology

A report about initial survey findings concerning information technology/ microcomputer projects for women in EC countries. CEDEFOP (European Centre for the Development of Vocational Training).

Luxembourg: Office for Official Publications of the EC, 1986, 107 pp. Languages: ES, DE, EN, FR, IT.

Women, technical training. Microcomputers. Information technology. Target groups. Continuing vocational training. Pilot projects. Training courses. Training objectives. Certification. Surveys. Reports. EEC countries.

This report summarizes the results from a survey of 15 information technology/ microcomputer projects for women. Its purpose is to provide an initial overview of the few women's projects in the European Community specifically oriented towards microcomputer technology in order to formulate more precise questions and recommendations for a discussion about promoting such training.

Communication from the Commission to the Council

Vocational training and the new information technologies

Work programme 1985 – 1988

Commission of the European Communities

COM(85) 167 final, 13 pp. + annex. Languages: ES, DA, DE, GR, EN, FR, IT, NL, PT.

ISBN 92-77-05374-7 ISSN 0254-1475

Vocational training. Information technology. Occupations. Skills. Training programmes. Women workers. Youth, return to work. Entry into working life.

The present paper sets out the broad lines of the Community action for the period 1985-1988, at the end of which a final report must be presented by the Commission to the Council.

The Community underlines the necessity of paying particular attention to certain areas of common interest. Due regard must be given namely to: meeting the needs of enterprises, in particular small and medium undertakings; preparing young people for working life, in particular those whose qualifications are inadequate; helping skilled workers to retain or regain employment; and the training and re-training of women.

Alfthan, Torkel

Developing skills for technological change: some policy issues

International Labour Office (ILO)

In: International Labour Review, 124, 1985, 5 pp. 517-529.

ISSN 0020-7780

Skill development. Technological change. Training policy. Secondary sector. Training-employment relationship. Work organization.

Technological innovations are bound to have far-reaching repercussions on the content and organization of work and hence on the skills, qualifications and attitudes required of the workforce. They can also do much to enhance the quality of life by providing better products and services, upgrading work, increasing productivity, and raising incomes. If workers are to reap their share of the benefits, however, they must be given the sort of training that will equip them to meet the challenge posed by these new work demands. The effects of technological change on jobs and the implications for training policies are discussed here in the context of the manufacturing sector.

New information technologies: a challenge for education.

Organization for Economic Cooperation and Development (OECD)

Paris: OECD, 1986, 121pp. Languages: EN, FR.

ISBN 92-64-12824-7

Information technology. Learning. Educational systems. Educational policy. Teachers. Curriculum. Budget. Innovations. Forecasting. Reports. OECD countries.

The new information technologies are already penetrating the education sector, inspired by objectives, policies and implementation strategies which vary considerably between countries. This report provides a first evaluation of current trends and examines the impact of developing technologies on learning and education systems.

Compendium Euro Tecnet

New information technology and vocational training

A network of demonstration projects. European Centre for Work and Society (ECWS)

Maastricht: Presses, Universitaires européennes, 1986, 389pp. Languages: EN, FR.

Information technology. Vocational training. EC Commission, ECWS, PO Box 3073, 6202 NB Maastricht.

The Commission of the European Communities has launched an action programme in the field of new information technologies and vocational training, consisting of a network of demonstration projects, here presented in a Compendium, and a programme of concerted research articulated in a certain number of key themes. The purpose of the network is to make a distinct contribution to the programme of activities concerned with technological change and its effects, which the European Community has developed with Member States. The four priority areas are: small and medium enterprises, young people, adult skilled workers and women returning to work.

B

By:
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Centre intercommunautaire de documentation pour la formation professionnelle
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CIDOC
ICODOC

Carpreau R.; Colla A.

Employment prospects for young graduates in the Flemish Region

(Tewerkstellingsperspectieven voor jonge afgestudeerden in het Vlaams Gewest)

Brussels, Vlaamse Economische Hogeschool, 1986, 81 pp. + annexes

Training-employment relationship. Labour supply. Manpower needs. Technological change. Research reports. Surveys. Employers. Training needs. Skill requirements. Communication skills. Practical skills. School-enterprise relationship. Region of Flanders. Belgium.

This study of employment prospects for young graduates in the Flemish Region, which was carried out at the request of the President of the Flemish Executive, uses a variety of methods to analyse, in both qualitative and quantitative terms, the supply of and demand for graduates. One method involved a survey of innovative firms aimed at discovering whether such firms have significantly different expectations from more traditional businesses regarding potential employees. The results relate *inter alia* to the content and level of educational and other qualifications (including social skills, knowledge of languages, occupational knowledge and skills, general education and familiarity with computers), the shortcomings of applicants from the employers' viewpoint and firms' desire for closer collaboration between the worlds of education and industry. The authors sum up this section of their study with the words: '"Fewer but better" is what firms want'.

Eysacker, E.; Roelandt P., *et al.*

Inventory of social-science research in Flanders relating to new technologies and the processes of Flanders relating to new technologies and the processes of social change (Inventaris van het Sociaal-wetenschappelijk onderzoek in Vlaanderen met betrekking to nieuwe technologieën en maatschappelijke veranderingsprocessen) Part 1: Research centres

Antwerp, Sociaal-economische Raad van Vlaanderen (SERV), Stichting Technologie Vlaanderen (STV), 1986, 328 pp.

Technological change. Directories. Research programmes. Research centres. Skill analysis. Vocational training. Training-employment relationship. Region of Flanders. Belgium.

This report sets out the results of a survey carried out in 1985 in which some 600 research centres in Flanders were asked what research had been carried out in the field of new technologies and the processes of social change, by whom, on what specific topics and with what results. Information was received on the content, personnel, duration, collaborative links, publications and specific characteristics associated with 111 research projects, some of which were scheduled to continue into 1987, 1988 or 1990. This annually updated data-base, which can be accessed in a variety of ways, includes projects relating to education and training (e.g. changing occupational profiles in various sectors in response to technical change), the education/employment interface, computer-aided learning, quantitative and qualitative aspects of employment in small and medium-sized firms and the desirability and feasibility of Information Technology Centres (ITECs) in Flanders.

Smet, R.

Technical development and its effects on education

(De technische evolutie en haar gevolgen voor het onderwijs)

In: Nova et Vetera, 1/2, 1985 – 86, 11, pp. 95 – 120.

Educational philosophy. Educational innovations. Technological change. Technology transfer. Technicians. Skill development. Vocational training. School-enterprise relationship. Educational planning. Youth unemployment. Computer-assisted instruction. Region of Flanders. Belgium.

Having defined the relevant technical and technological concepts the author examines the impact of technical development on the individual and society. Given that modern technology represents a synthesis of several disciplines it is inevitable that ever increasing knowledge will be demanded of those who work in this field and that their training will become ever more complex and extensive. After outlining the thought patterns and profile of the technician and technologist the author goes on to consider the relationships between general and vocational education and between the worlds of education and industry, supplementing his conclusions with a number of proposals. Finally he looks forward to the future, considering the impact of the new technologies on eudcation from three viewpoints: youth unemployment, technical development and changing occupational qualifications.

Information Sources

Donckels, R.

Innovation in small and medium-sized enterprises in Flanders: opportunities and limitations

(Innovaties in de Vlaamse KMO's: mogelijkheden en beperkingen)

Brussels, Universitaire Faculteiten Sint-Aloysius (UFSAL) Text for SME seminar held on 26 February 1985 in the framework of Flanders Technology International, 10 pp.

Small and medium enterprises. Innovations. Technology. Automation. Training needs. Region of Flanders. Belgium.

Professor Donckels analyses the significance of process and product innovation in small and medium-sized firms in Flanders and identifies a number of internal and external environmental factors which determine whether such firms innovate. He also deals with the question of the specific functions within business and industry to which innovation may relate and investigates the scope for the computerization of management processes. The need is brought out for training and support to ensure that managers and their immediate subordinates have a clear understanding of all that is involved.

IST (Institut des sciences du travail de l'Université Catholique de Louvain – Louvain Catholic University's Institute of work sciences)

Comprendre et maîtriser la bureautique

Guide de lecture d'un changement.
[Understanding and mastering office information. Reading guide to a change]
Louvain-la-Neuve, IST, 1984/6, 227 pp.

Vocational training. Computer science. Tertiary sector. Clerical workers. Belgium.

This comprehensive report on office automation includes a paper by J.J. Degroof on the restructuring of office work around the new computer technologies (pp. 23 – 53).
When office work is computerized, administrative expertise is usually automated and replaced by technology-linked expertise, but the main question raised by the introduction of office information is how to train employees with multiple expertise.

Ministère de l'Education Nationale – Belgian Ministry of Education

La formation professionnelle et les nouvelles technologies de l'information

[Vocational training and new information technologies]

Brussels, Ministère de l'Education Nationale, 1986, 10 pp.

Computer science. Information technology. Training needs. Training supply. Institutional framework. Region of Brussels. Region of Wallonia. Belgium.

This is a summary account of a one-day national conference on 16 May 1986 attended by representatives from public-sector education and training from the Ministry of National Education, the Office National de l'Emploi (National Employment Board), the Ministry for Small Firms and Traders and FEB (Fédération des Entreprises de Belgique – the Belgian employers' federation). The central issues discussed in workshops and the general conference were how to prepare for the changes generated by new technology, how to adapt the vocational training provided in the public sector to meet the changing needs in the workplace and how to create synergy among those involved in training.

Coppe, F.; Berhin, D.

Informatique – Professions – Formation

[Computer science – occupations – training]

Brussels, SIEP (Service d'information sur les études et les professions – education and careers information service), 1985, 219 pp.

Computer science. Vocational training. Training supply. Skills. Skilled occupations. Belgium.

This book aims to provide a comprehensive list of occupations in the field of computer science and with computer manufacturers and software houses. Most of the book is taken up by a systematic description of the training courses leading to those occupations that are available in French-speaking Belgium, to include those in the State and private education systems as well as those offered by the Office National de l'Emploi (National Employment Board) and the Ministry for Small Firms and Traders.

Willems, P.; Donné, L.; De Meyer-Vileyn

Computer applications in commercial education, Report 4

(Gebruikersinformatica in het handels- en economisch onderwijs, Rapport 4)

Hasselt, Limburgs Instituut voor Onderwijsonderzoek en Oriëntatie (LIOO), 1986, 104 pp.

Computer applications. Administrative personnel. Clerical workers. Skill analysis. Training needs analysis. Training programmes. Pedagogics. Clerical training. Commercial training. Secretarial training. Secondary education. Higher education.

This study sought to identify (a) the knowledge, skills and personal characteristics which the individual needs if he/she is to operate satisfactorily as a user of information technology in a commercial/administrative environment and (b) the contribution which education can make to preparing young people for work in this field.

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Hoffmeyer, Niels

Forsknings- og industripolitik in Danmark og udlandet (Research and industrial policy in Denmark and abroad) Danish Engineers' Association

Copenhagen, 1985, 46 pp.

ISBN 87-87254-204

Research policy. Industrial policy. Europe. Japan. USA. Denmark.

In the summer of 1984 it was pointed out, in a report on the Danish economy, that Danish industry is technologically deprived, despite the fact that thousands of millions of kroner have been invested in training and millions of kroner in promoting technology.

Europe has in the last few years been exposed to very keen competition from the USA and Japan. The countries of Europe – including Denmark – have all reacted to this competition with so-called 'technology programmes' or measures of government aid which are intended to help to finance industry's use of new information technology. The author does not consider these measures adequate and proposes that all of the numerous decision-makers in Denmark who are of significance for the innovation process should be gathered together in a new Ministry for Technology, with the primary task of setting this process in motion.

JUUST. Report 2

An experimental project financed by the participating firms and Jern- og Metalindustriens Uddannelsesfond

(Iron and Metalworking Industry's Training Fund)

Barford, Ari; Brinck, Flemming *et al.* (authors)

CO-Metal (Central Organization of Metalworkers in Denmark). Jernets Arbejdsgiverforening (Iron and Steel Trades' Employers' Association).

Copenhagen, 1986, 107 pp.

Further training. Metalworking industry. Pilot projects. Denmark

The experimental project JUUST (Jernets Udvikling af UddannelsesSysTemer) came into being as a collaborative project between CO-Metal and the Iron and Steel Trades' Employers' Association. The purpose of the project is to find out what the skill requirements are, qualitatively and quantitatively, for employees in firms in the iron- and steel-working industry.

17 of the biggest firms in the iron- and steel-working industry, with a total of 27 000 employees, took part in the project. The report points out that there is a need for every employee in the industry to participate in 10 days' updating and refresher training a year, i. e. 4.7 % of working time per employee per year. If this need is to be satisfied, the amount of updating and refresher training given must be many times more than at present. In the report, the firms stated also that there is a need for faster, more flexible and more individual adaptation of existing courses, as well as faster growth of new training opportunities, based upon the actual need of the firms for skilled employees, now and in the future.

Højer, Peter; Kjærsgaard, Christian; Laursen, Thomas Mosfeldt

Nye uddannelser i industrien. Grundlag for planlægning (New training schemes in industry. Basis for planning)

Roskilde University Centre, Department of Environment, Technology and Sociology

Roskilde, 1986, 370 pp.

ISBN 87-87893-35-5

Industrial training. Educational planning. Regional planning. Job requirements. Research reports. Denmark.

The report is a revised edition of an examination project at the Roskilde University Centre. In the project, the demand-aspect of the development conditions for the training system is examined. Whatever objectives are formulated at various levels for the public training system, the content of the vocational training and labour-market training should always respond to some extent to demands of private industry.

The central area for analysis in the project is the relationship between the growth in industry's demand for skills and public training-planning.

The project includes an actual empirical analysis of skill-requirements of three firms in processing industry in Denmark. The three firms employ primarily unskilled labour in production. The new skill specifications, changing in step with technological development, are described in the analysis. The analysis forms the background to an appraisal of the three firms' need for formalized training.

Information Sources

Betænkning om ingeniør- og teknikeruddannelsernes fremtid

(Report on the future of engineer- and technician-training, Copenhagen, Statens informationstjeneste)

(National Information Service), 1986, 231 pp.

Report 1074

ISBN 87-503-6192-9

Technical education. Forecasting. Proposals. Reports. Denmark.

In August 1985, the Danish Ministry of Education appointed the Committee on the future of engineer- and technician-training, with cand. polit. Steffen Moller, consultant, as chairman.

One of the tasks of the Committee was to draw up a programme of action, including measures to ensure that in future a sufficient number of engineers and technicians receive both basic training and updating and refresher training, to an advanced level with skills to match tomorrow's needs.

The Committee's report was published in June 1986. In it, the conclusion was drawn that, towards the end of the 1990s, twice the number of employees at engineer-level will be required (today there are about 45 000), and three times the number of employees with functions corresponding to the present advanced technician-training (today there are about 30 000). This will mean an approximately threefold increase in the intake to further technician training-courses and an increase of more than 50 % to engineer training-courses.

The existing channels of direct access to technician- and engineer-training are to be maintained – including the feature that technician training-courses are usually further training courses for specific basic vocational training, apprentice training and basic technician training. As an innovative feature, the establishment locally of preliminary technician- and engineer-training courses (TIF) is recommended. TIF are to be able to offer modules and individual subjects to groups of those seeking training who need to have their preliminary technical or theoretical knowledge supplemented for entry to the engineer- and technician-training courses.

The Committee also points out in the report the desirability of having the engineer- and technician-training courses spread as widely as possible, geographically. Lastly, the Committee discussed the question of teacher recruitment and conditions for teachers. It was found that many teachers are at present turning to private industry, and the Committee therefore refers to a number of concrete proposals which can improve conditions of work for teachers. The report ends with a draft law concerning technicians.

Sammenhæng og koordinering mellem arbejdsmarkedsuddannelserne og erhvervsuddannelserne

(Connection and co-ordination between labour market training schemes and vocational training schemes).

Finance Ministry's regular review. Ministry of Finance, Administration Department

Copenhagen, 1986, 129 pp. + Appendix

Training policy coordination. Vocational training. Labour market. Reports. Denmark.

This report has been prepared as part of the Finance Ministry's regular review of the functions and activities of the public authorities. In the review, an attempt is made to elucidate the following circumstances, in particular: (1) Whether interaction between basic training schemes and occupational updating and refresher training schemes has been arranged centrally, so that school equipment and teachers can be used and applied to the best possible advantage. (2) Whether the directorates' consent and planning procedures have been appropriately arranged. (3) Whether the organizational structure and administrative arrangement of the training programmes provide assurance that mutual influencing takes place between updating and refresher training of skilled personnel and basic training. (4) Whether the training system can react flexibly and quickly to problems of conflict or deficiency on the labour market.

Regarding the use of resources, the review has shown that no mechanisms and procedures exist centrally which ensure appropriate utilization.

Information Sources

F

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Vocational training: one factor in technological progress

Technologie – travail – formation

(Technology – work – training)

Les Cahiers de l'Iforep, No 48, June 1986, 101 pp.

Technological change. Robotics. Work organization. Employment situation. Skills. Continuing vocational training. Automobile industry. Nuclear industry. Aircraft industry. France.

Iforep (Institut de Formation, de Recherche et de Promotion – the Institute of Training, Research and Advancement) publishes a series of 'Cahiers' reporting on research conducted by Lastree (Laboratoire de Sociologie du Travail, de l'Education et de l'Emploi – Laboratory of the Sociology of Work, Education and Employment) in four fields: the car manufacturing industry, nuclear energy, distribution within the French electricity and gas corporations and the aviation industry.

The authors' aim is to shed light on the relations between work and training by adopting a threefold approach: an overview of current technical changes, an analysis of the ways in which work systems are changing and thought as to the challenges to training in the context described.

Aluminium Péchiney

Un plan de qualification

(A plan for the upgrading of job skills)

Training schemes. Retraining. Alternation training. Youth. Technological change. Metalworking industry. France.

Aluminium Péchiney is a nationalized company which, in 1984, launched a major three-year training plan to upgrade its employees' skills and help them adapt to technological change. The investment outlay in the skill training of 900 employees was equivalent to 5 % of the company's wage bill.

This report on the plan is in two parts:

■ A general description of the plan put into effect by the company in liaison with the Education Ministry, with a section on alternance training designed to impart skills to young people.

■ An account of how the plan was implemented at one of the company's locations in the Rhône-Alpes.

RATP et nouvelles technologies

(Paris public transport and new technologies)

In: Flash Formation Continue, Nos 220 and 221, March 1986, pp. 11–16 & 8–13.

Office automation. Work organization. Job content. Skills. Training schemes. Administrative personnel. Urban transport. France.

This file contains the analyses and proposals of a study group which was asked to consider the effects of introducing new technology on the administrative side of RATP (Régie Autonome des Transports Parisiens – the Paris public transport system). The first part of the report is a review of the consequences of the introduction of new technology, particularly word processors, on the corporation's administrative practices, the changing pattern of skills and job content.

In the second part, proposals arising from the new situation are discussed and aspects of the plan for the restructuring of jobs are described (the members of the workforce affected and the methodology employed).

Information Sources

Adaptation aux technologies nouvelles:

premier bilan de la mise en place d'un important plan de formation pluri-annuel par la société industrielle Bernard Faure

(Adapting to new technologies: a preliminary review of the introduction of a major multiannual training programme by the Bernard Faure industrial company)

In: Formation Développement, No 75, January-March 1986, pp. 31 – 121.

Training schemes. Retraining. Technological change. Evaluation. France.

Société Industrielle Bernard Faure (SIFB) devoted 4 % of its 1984 and 1985 wage bill to setting up a plan on adapting to new technologies, under which 372 of its employees underwent training.

The journal *Formation Développement* publishes several papers on the training plan:

- description of the content of the plan and the difficulties encountered on its introduction;
- a quantitative and qualitative appraisal of action taken as of 30 June 1985.

Dossier: CAP BEP, bacs professionnels: quelle formation pour les ouvriers et les employés?

(Dossier on technical and vocational education: the best training for the shop-floor and office?)

In: Iretep, No 5, January-March 1976, pp. 3 – 75.

Vocational training. Technical education. Educational policy. Teacher unions. Acts. France.

Technical and vocational education of quality must be developed if we are to cope with technological change. Iretep (Institut de Recherche sur les Enseignements Techniques et Professionnels – Technical and Vocational Education Research Institute) has compiled a major report on the new forms of education in technological subjects which attempt to reconcile budget and scholastic requirements with job prospects, i.e. courses leading to the Certificat d'Aptitudes Professionneles (certificate of vocational competence), the Brevet d'Enseignement Professionnel (certificate of vocational education) and the Baccalaureate in vocational subjects. It also covers action by ministerial departments, the unions and the authorities and its influence on the development of vocational education courses.

MARGER, Pierre-Louis

Les enjeux de la formation professionnelle face aux mutations des techniques industrielles

(Changing industrial techniques: the challenges to vocational training)

Noisy le Grand: Asdep, 1985, 112 pp.

Technological change. Automation. Skills. Work organization. Technical training. In-plant training. France.

This report considers the potential role of vocational training in meeting the challenges of technological change. It tackles three themes:

- the changing pattern of skills,
- technological culture as a means of keeping abreast of technical progress,
- the integration of training strategies in the company's technical decisions.

The report states goals in connection with each theme and makes proposals on mobilizing the people involved and comparing their experience.

Information Sources

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Telefoon (0 73) 12 40 11

Zegveld, W.; Enzing, C.

New issues in science and technology policy

(Nieuwe issues in het wetenschaps- en technologiebeleid)

Ministry of Education and Science, Zoetermeer, 1986, 80 pp.

ISBN 90-346-0868-9

Science and technology. Science policy. Industrial policy. Trade. Employment. Netherlands.

Analysis and description of developments in science and technology in relation to science and technology policy in the industrialized countries, processes of innovation, industrial structure, the role of industry and the university, international trade, the relationships between technology and employment, the management of knowledge and information. Summary and conclusions.

Ten Dutch demonstration projects in connection with Euro Tecnet

Pedagogisch Centrum Beroepsonderwijs Bedrijfsleven (PCBB) 's-Hertogenbosch, 1986, 26 pp. (in English)

Technology policy. Vocational training. Pilot project. Adults. Job analysis. Office automation. Women. Apprenticeship. Employment. Unemployment. Netherlands.

Brief description of the 10 Dutch Tecnet demonstration projects. Attention is also devoted to government technology policy. Survey of vocational training facilities.

Information technology and employment, situation and prospects

(Informatietechnologie en werkgelegenheid, inzichten en vooruitzichten)

Ministry of Employment and Social Security, Department of General Policy Planning, The Hague, 1986, 51 pp.

ISBN 90-363-9571-2

Information technology. Employment. Ministries. Industries. Vocational training. Netherlands.

An outline of the main applications of information technology and their consequences for employment is followed by a description of the sectoral structure of the Dutch economy, the effect of firms' size and of Dutch firms' position in the international economy and an examination of the interactions between information technology and economic structure. Finally the consequences are discussed of the anticipated application of information technology in terms of changes in occupations, training needs and the organization of labour.

van Bueren, H. G. *et al.*

Science, politics and industry

(Wetenschap, politiek en bedrijfsleven)

Stichting Maatschappij en Onderneming, SMO inf. 86-3, 59 pp.

ISBN 90-6962-016-2

Technological change. Universities. Science policy. Enterprises. Netherlands.

Collection of papers on the issues which are at stake in the reassessment of the role of the university in our rapidly changing society.

van Empel, F.

Failing education

(Het falende onderwijs)

In: Intermediair 22 (1986) No 10, pp. 27, 29, 30, 33

Technological change. Higher education. Computer science. Enterprise. Netherlands.

An investigation of the severe shortage of specialists in information technology in industry and the problems which education faces in attempting to supply-well trained personnel.

Progress report of the working group on technology transfer

(Voortgangsrapport van de Werkgroep technologietransfer)

Ministry of Economic Affairs, The Hague, 1985, 28 pp.

Ministries. Technological changes. Vocational training. Netherlands.

Recommendations aimed at helping vocational education and training to respond to the demands made by new technologies and new product and market combinations.

Information Sources

van Heene, J.; Plomp, T. (eds.)

Education and information technology, symposium report

(Onderwijs en informatietechnologie, veslag van een SVO/COD symposium)

Stichting voor Onderzoek van het Onderwijs (SVO), The Hague, 1986, 313 pp.

ISBN 90-6472-059-2

Information technology. Research. Computer-assisted instruction. Vocational training. Education and training. Netherlands.

Report on a symposium held on 11 and 12 October 1984 by the Educational Research Institute (SVO) on the need for research in the Netherlands and Flanders in the area of education and information technology. The papers deal with: computer-assisted learning systems; knowledge-based systems in education; the impact of information technology on the education system and on special education; initial and in-service training of teachers; computer-aided testing; developments in other countries.

Suesan, N.; Tops, M. W.; Wijers, G. J.

Industry on the way up

(Bedrijfsopleidingen in de lift)

Bakkenist, Spits & Co, Ministry of Employment and Social Affairs, The Hague, July 1986, 104 pp.

Research. Training. Industry. School-enterprise relationship. Technical change. Netherlands.

Report on research covering 46 firms with more than 300 employees and five commercial training institutions. Every year 35 % of the workforce of the firms visited receive some form or other of training, with older employees tending to be left out. Mainstream education is not adequately geared to the needs of industry. Firms mainly provide courses geared to the requirements of particular jobs within them or of the firm as a whole, notably in the areas of information technology, technical subjects and commercial and management training. Systematic links between the government's technology policy and industrial training are considered desirable.

Higher education, technology and the market sector

(Hoger onderwijs, technologie en de marktsector)

Lower House of Parliament; Ministers of Education and Science and Economic Affairs; Paper No 19 454, 1985-86 session, Zoetermeer, 14 March 1986

Higher education. New technologies. Labour market. Educational policy. Ministry of economics. Ministry of education. Netherlands.

The Ministries of Education and Science and Economic Affairs have devoted the sum of 100 million guilders to measures to improve links between the universities and higher vocational institutions on the one hand and industry on the other. The sum of 25 million guilders has been earmarked for the promotion of a number of activities in this field. The amount available for in-service training for teachers in technical education is 75 million guilders. This project may later be extended to cover other employers and the unemployed. These funds have been set aside from the current budgets.

New technologies: changes in industry and education

(Nieuwe technologieën: veranderingen in bedrijf en onderwijs)

Sociaal Economische Raad (SER), Commissie voor Ontwikkelingsproblematiek van Bedrijven (COB), The Hague, April 1986, no. 86-72

ISBN 90-6587-236-1

Technological changes. Enterprises. Education and training. Information technology. Research. School leavers. Job analysis. School-enterprise relationship. Netherlands.

This study examined a large number of occupations filled by school-leavers with mainly general (non-vocational) educational qualifications working in firms and institutions in the forefront of the application of information technology. Changes in occupational profiles were identified and put before panels of experts from the world of education. The study sought to promote interaction between changing training needs in industry and changing learning objectives in education.

Kayzel, R.; van Wel, J.

Changes in occupational practice and their consequences for vocational training, research report

(Veranderingen in de beroepspraktijk van vakmensen en gevolgen voor de beroepsopleidingen, verslag van een onderzoek)

Stichting voor Onderzoek van het Onderwijs (SVO), Instituut voor Toegepaste Sociologie, The Hague, 1985, 182 pp. Selecta series.

ISBN 90-6472-062-2

Research. Vocational training. Metal-working industry. Chemical industry. Occupational qualification. Professional workers. Netherlands.

Since the late 1960s innovations in the computer field have given a major impetus to technological development, with radical changes taking place in the technology and organization of production processes. What consequences are these developments having for the skilled occupations? Part one of this study begins by analysing the qualifications and career of the traditional skilled worker and goes on to identify, on the basis of case studies in the metal products industry and the process industry, the changes that are taking place in craft skills. Finally a typology is proposed of new forms of craftsmanship in automated production processes. Part two then considers the changes that have taken place in vocational education and training in the two sectors and the degree to which these fit in with the changing pattern of craft skills.

Information Sources

UK

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CNC in FHE:

A review of the requirements and resources for computer numerically controlled machine tool systems in colleges and polytechnics

Further Education Unit (FEU) York: Longmans, 1985, 49 pp.

ISBN 0582 173 54X

Automation. Technological change. Engineering. Computer applications. Training courses. Training needs. Educational resources. Further education. Polytechnic education. Curriculum development. Examinations.

A review of recent developments in computer-controlled (CNC) machine tools. There is a brief survey of the current availability of CNC courses and equipment in England and Wales and the report concludes that for effective use of expensive CNC resources, a nationally coordinated network of support for CNC teaching is required and regional advisory centres should be established.

Education and training for new technologies

Three volumes. House of Lords. Select Committee on Science and Technology. London: HMSO, 1985, 88 pp.; 378 pp.; 480 pp.

ISBN 0 10 491085 2

Education and training. Vocational training. Training systems. Technical training. Industrial training. Information technology.

This report by the Select Committee on Science and Technology is divided into three volumes. Volume 1 – the report, describes the education and training system of the UK and its importance to manufacturing industry and ultimately the economic prosperity of the UK. The emphasis throughout the report is on information technology and the need for suitably qualified manpower. Volumes 2 and 3 provide the oral and written evidence presented by major industrial, technical and educational establishments.

Northcott, J.

Microelectronics in industry. Promise and performance

Policy Studies Institute (PSI) London: 1986. 258 pp.

ISBN 0 85374 278 2

Microelectronics. Technological change. Skilled workers. Manpower needs. Training supply. Labour market. Occupational structure. Job loss.

A report which examines the impact of microelectronics on industry and the reaction to this form of technological change. The report considers the extent to which microelectronics have been introduced into factories, the difficulties encountered and the level of help available from the government in the form of subsidies etc. It also investigated the effect that introducing microelectronics had on the labour force, the skills needed, and the changes brought about in the labour market including job losses and alterations in the occupational structure.

Burgess, C.

The impact of new technology on skills in manufacturing and services

Manpower Services Commission (MSC), Sheffield: 1986. 127 pp.

ISBN 0 86392 142 6

Technological change. Job requirements. Labour market. Skilled workers. Industry. Services.

Focuses on the impact of technological change on occupational skills over five years and attempts to identify significant gains and losses.

Brady, T.

New technology and skills in British industry

Manpower Services Commission (MSC) Sheffield: 1986. 124 pp.

ISBN 0 86392 146 9

Technological change. Labour market. Job requirements. Skilled workers. Job design. Occupational structure.

Investigates the implications of new technology for the skills of certain occupational groups. Examines the impact on the skill factors in job design, and assesses the amount of de-skilling involved and the trends towards multi-skilling.

New technology in design and manufacture

Coombe Lodge Report, 17 (9), 1984, 40 pp.

ISBN 0305-8441

Technological change. Computer application. Curriculum development. Further education. Education innovations. Training needs. Technical education.

A collection of conference papers concerned with the curriculum implications of technological change and how the further education system is meeting this challenge.

Information Sources

Thompson, L.

New office technology: people, work structure and the process of change

Work Research Unit (WRU) London: 1985. 35 pp.

Office automation. Work organization. Technological change. Training needs.

Traces the impact of office automation over the past four years on work organization and the process of change which results. The attitudes of management, trade unions and the government are looked at, as well as the reactions of the workers most affected by the introduction of new technology. Annexes list checkpoints for the introduction of office automation and preconditions for its favourable implementation.

The impact of new technology on skills in manufacturing and services: A review of recent research

Manpower Services Commission (MSC), Sheffield, 1985, 127 pp.
ISBN 0 86392 142 6

Technological change. Job requirements. Skill development. Industry Services. Research reports. Training needs.

This paper looks at the recent research into the impact of technical change on skills in the manufacturing and service sectors. The report is made up of 11 sections dealing with various issues including management, technologist and technician skills and changes in various service industries.

Vincent, B; Vincent, T.

Information technology and further education

London: Kogan Page, 1986, 131 pp.
ISBN 0 85038 994 1

Information technology. Further education. Curriculum development. Educational resources. Handicapped persons. Training policy.

Examines the current applications of information technology within the further education curriculum and gives a brief overview of the major projects working in the area. It also considers the impact of technology on the curriculum of disabled students. The final section covers vocational education and training issues.

Burgess, C.

Skill implications of new technology

Employment Gazette 93 (10) 1985. p. 397 (7 pp.)
ISBN 0309 5045

Skills. Occupational structure. Technological change. Skill obsolescence. Job dislocation.

Reviews the effects of the adoption of new technology on occupational skills in the manufacturing and service sectors. It also looks on the national skill structure.

Gordon, A.; Pearson, R.

Manpower for information technology

Institute of Manpower Studies (IMS) Brighton: 1984. 108 pp.

Information technology. Higher education. Curriculum subjects. Recruitment. Manpower needs. Students. Educational background. Access to employment.

As part of a programme to identify employers' needs for employees with information technology skills and to examine the employment patterns of graduates with IT skills, this preliminary report surveys the current provision of courses; examines the recruitment of graduates by employers; analyses the background and destinations of the students; and looks at methods of monitoring the area of education provision.

Liff, S.

The technology monitor 1983-4

Manpower Services Commission (MSC) Sheffield: 1986. 42 pp.
ISBN 0 86392 145 0

Technological change. Labour market. Job requirements. Skilled workers. Occupational structure. Information service.

The Technology Monitor is a data base built up to monitor technological innovations and their potential impact on the labour market, its occupational structure, and the skill requirements within it. The report summarizes the findings across a variety of industries.

Skill shortage information seminar

Manpower Services Commission (MSC), Sheffield: 1986. 200 pp.
ISBN 0 86392 143 4

Technological change. Labour market. Job requirements. Skilled workers. Information sources.

The seminar aimed to discover methods of monitoring skill shortages by improving information systems. The monitoring includes the nature, incidence, extent and significance of the shortages.

Information Sources

The remaining pages of this section contain bibliographical references relating to publications, which in the opinion of the members of CEDEFOP's Documentary Information Network were the most important recently published in the field of vocational training in their country, which are also likely to be of interest to those coming from 'abroad'. This is an innovation which we intend to continue in further editions of the Bulletin, although pressure on space plus considerations of availability of material, will mean that only a few Member States will be included in each issue. Readers who know of publications which they consider might be of interest to colleagues in other countries are invited to communicate this information to CEDEFOP, or, preferably, to the network member in the country of publication.

B

Office National de l'Emploi

Centre intercommunautaire de documentation pour la formation professionnelle

Sixteenth international symposium on industrial robots (ISIR), symposium day on education

IFS – Belgisch Instituut voor Regeltechniek en Automatisering (BIRA)

BIRA, Antwerp, 1986, 119 pp.

Training schemes. Training needs analysis. Robotics. Training of trainers. Training systems. Training levels. Job requirements. Curriculum development. Industrial training. School-enterprise relationship. Institutional framework. Training material. Conference reports. United Kingdom. Austria. Canada. Belgium.

1 October 1986 was devoted to an exchange of views and experiences regarding education and vocational training in the field of robotics. Following a number of case discussions from different countries descriptions were given of existing training structures and views put forward regarding desirable future developments. Most speakers stressed the need for multidisciplinary action, while the wide range of training needs at different levels imply an ongoing process of curriculum development. On the industrial side attention was focused on the importance of the employee's personality characteristics and the need for continuing training. Most speakers felt that long-term action needed to focus on the training of trainers and on ensuring that trainers have at their disposal appropriate curricula, training hardware and software and so on. Effectively coordinated training activities require investment by industry as well as government. All the speakers' texts are in English.

Febelgra (Fédération Belge des Industries Graphiques – Belgian printing and graphic industries federation).

A survey on job profiles and educational requirements in the printing and allied industries.

Brussels, Febelgra, 1986, 25 pp. + annexes

Surveys. Needs training. Graphic arts. Computer science. Electronics. School-enterprise relationship. Job requirements. Région bruxelloise. Région wallonne. Region of Flanders. Belgium.

This booklet, in French and Dutch, sets out the findings of a recent national survey on training needs in the Belgian printing industry. Electronics and the computer have radically changed the skills required in the printing trades and, as a result, in the form and content of training.

The survey calls for:

(i) prompt action to ensure that technical and vocational training courses reflect new computerized printing technologies,

(ii) an end to certain out-of-date courses,

(iii) collaboration with the printing industry on arranging periods of practical application of what is being learned.

A set of data sheets is enclosed: they redefine in precise terms what employers require in the way of job skills for each printing technique.

CATE (Club Athena Technologies – Education)

Techeduc: technologies nouvelles et formations de base

(Techeduc: new technologies and basic training)

Brussels, CATE, 1986, 170 pp.

Computer science. Basic training. Training levels. Training policy. Training programmes. Brussels Region. Walloon Region. Belgium.

This is a report on the proceedings of an April 1986 colloquium on the introduction of new technology into the school, attended by educationalists and trainers. The aim was to arrive at an overall policy for education and training, focusing on the development of technology-mindedness in the school, technical education and psycho-sociological training. In a series of workshops on each application of technology (robotics, office automation, biotechnology, etc.), the participants defined the specific levels of education which could serve as guidelines for new school curricula; the learning of new technologies could be gradually introduced into the school throughout the period of education and up to the time of entering the working world.

Information Sources

CATE (Club Athena Technologies – Education)

E + E = 100. Enquête Formations-Entreprises Wallonie-Bruxelles

(E + E = 100. A survey on training and employers in Wallonia and Brussels)

Brussels, CATE, 1986, 162 pp.

Surveys. Computer science. School-enterprise relationship. Training levels. Educational levels. In-plant training. Economic sectors. Brussels region. Walloon region. Belgium.

The aim of this recent questionnaire-based survey was to map out the main trends in the demand for training in new technology on the part of employers in Brussels and Wallonia. In the light of the survey findings, the report describes new technologies being used in the workplace, the sectors of industry where they are used, the level of training required of the workforce and employers' intentions as regards training. The findings are presented in the form of a set of tables on each of the aspects analysed. The conclusions of particular note are that:

- of the 13 branches of new technology listed, information processing and office automation are the most commonly used;
- for each form of new technology there is a growing demand for advanced but non-university type of training;
- a great majority of employers prefer to train their own employees using their own resources, but they want those employees to have a sound basic training so that they can readily adapt to new situations and methods;
- secondary education has an important role to perform in creating links with the workplace.

F

centre INFFO

Centre pour le développement de l'information sur la formation permanente

Projet de loi de finances pour 1987

(Finance Bill for 1987)

Document attached to Finance Bill: 'Formation Professionnelle' ('Vocational Training'), 1986, 94 pp.

Financing of training. Training levy. National budget. Alternating training. Regional planning. Training statistics. France.

In 1985, more than 3.6 million members of the active population – in other words, almost one person out of five – were involved in training schemes.

This enclosure to the Finance Bill for 1987 outlines the results of vocational training. It contains an overview of government and regional aid as well as participation by employers in 1985 (chapter II).

Chapter III contains a review of specific measures in favour of 16- to 25-year olds (work experience placements, adaptation contracts, skill acquisition contracts).

The budget for 1987 shows a rise of over 6 % in credit appropriations, which are grouped together under the general heading of 'vocational training'. It increases credits under this heading from FF 17 464 million in 1986 to FF 18 532 million for 1987.

Tugal, Marie; Lefort, Catherine; Brunn, Inger

Les lieux de ressources documentaires et les jeunes

(The location of documentary resources relating to young people)

Paris: Centre INFFO, 1986, 188 pp.

Youth. Entry into working life. Information sources. Directories. France.

A good deal of thought and analytical research is being devoted to the social and vocational integration of young people. Centre INFFO's documentation centre has identified some 80 public and para-public bodies, associations and international agencies working in favour of young people or making specialist documentation available.

A description is given of each of these bodies, its documentary resources, publications, research and complementary activities.

The publication has three separate indices: contents, the publications cited and audivisual resources.

Lucas, Anne-Marie; Pasquier, Josette; Lietard, Bernard

Les actions de formation: reconnaissance et validation des acquis

(Training measures: the recognition and validation of achievement)

Centre INFFO, September 1986

Vocational assessment. Attainment appraisal. Vocational guidance. Certification. Education credits. France.

Centre INFFO has produced a technical file on the recognition and official confirmation of competence acquired by young people and adults. It includes:

- a set of data sheets on various aspects of the assessment and validation of skills acquired in the course of training, employment and social life;
- a bibliography;
- a folder containing the text of legislation on the recognition and validation of the competence and skills of young people and adults, together with an index;
- a summary sheet.

Information Sources

NL

Pedagogisch Centrum Beroepsonderwijs Bedrijfsleven

van Kemenade, J. A.; Langerweij, N. A. J., *et al.* (eds.)

Education in outline

Education System and Policy 1

(Onderwijs in hoofdlijnen, Onderwijs Bestel en Beleid 1)

Groningen, Wolters Noordhoff, 1986, 525 pp.

ISBN 90-01-46681-8

Educational policy. Educational system. Netherlands.

This three-volume series is an extended and fully revised version of the one-volume 1981 edition. Part one outlines the education system itself, focusing attention particularly on: the structure of the school system and its historical development; quantitative data and financial aspects; the role and position of teachers; education and the law; international comparisons.

van Kemenade, J. A.; Langerweij, N. A. J., *et al.* (eds.)

Education and Society A

Education System and Policy 2

(Onderwijs en Samenleving A, Onderwijs Bestel en Beleid 2)

Groningen, Wolters Noordhoff, 1986, 303 pp.

ISBN 90-01-46682-6

Educational system. School-enterprise relationship. Equal opportunities. Netherlands.

This three-volume series is an extended and fully revised version of the one-volume 1981 edition. Part two is concerned with education and society, dealing in particular with: education and social inequality; education and ethnic inequality; education and sexual inequality; education and personal philosophy.

UK

BACIE

British Association for Commercial and Industrial Education

Jones, I.S.

Apprentice training costs in British manufacturing establishments: some new evidence

British Journal of Industrial Relations, XXIV (3), November 1986, p. 334 (26 pp.).

ISSN 0007-1080

Cost of training. Apprenticeship. Engineering. Technical education. Training research. Financing of training.

This paper presents the findings of a small sample enquiry into the net costs to the firm of apprentice training in British manufacturing establishments in 1984.

Keegan, D.

The foundation of distance education

Beckenham: Croom Helm, 1986, 276 pp.

Distance study. Educational theory. Curriculum development. Course design. Training evaluation. Training administration.

A general introduction to the theory and practice of distance education including a review of important developments.

Measures to reduce youth unemployment in Britain, France and West Germany

National Institute of Economic and Social Research (NIESR) Nat. Inst. Econ. Rev, No 117, August 1986, p. 43 (9 pp.)

Youth unemployment. Training policy. Training-employment relationship. Training programmes. Training abroad. France. Federal Republic of Germany.

A comparative review of the measures being taken in three Member States to reduce youth unemployment.

Information Sources

MSC Corporate Plan 1986 – 90

Manpower Services Commission (MSC)
Sheffield: 1986, 40 pp.
ISBN 0 86392 167 1

Employment policy. Training policy. Training programmes. Ministry of Vocational Training. Handicapped persons. Financial resources. Labour market. Annual reports. Labour statistics.

Outlines the MSC's future employment and training policy initiatives and programme developments for Great Britain including the financial resources needed. The report describes present and future labour market conditions before going on to describe expenditure; vocational education and training policy; employment services policy; unemployment and MSC management issues.

Marsden, D; Richardson, R.

Youth employment: A symposium

British Journal of Industrial Relations, XXIV (1), 1986, p. 25 (78 pp.).
ISSN 0007-1080

Youth unemployment. EC Members. Conference reports. Training abroad. Employment policy. Alternating training. Access to employment. Wages. France. Italy. Federal Republic of Germany.

Four papers originally presented at an international conference. Concerned with European youth unemployment. The articles cover: French employment policies for young people; youth unemployment in Italy: the impact of the dual system in West Germany and employment patterns in Europe.

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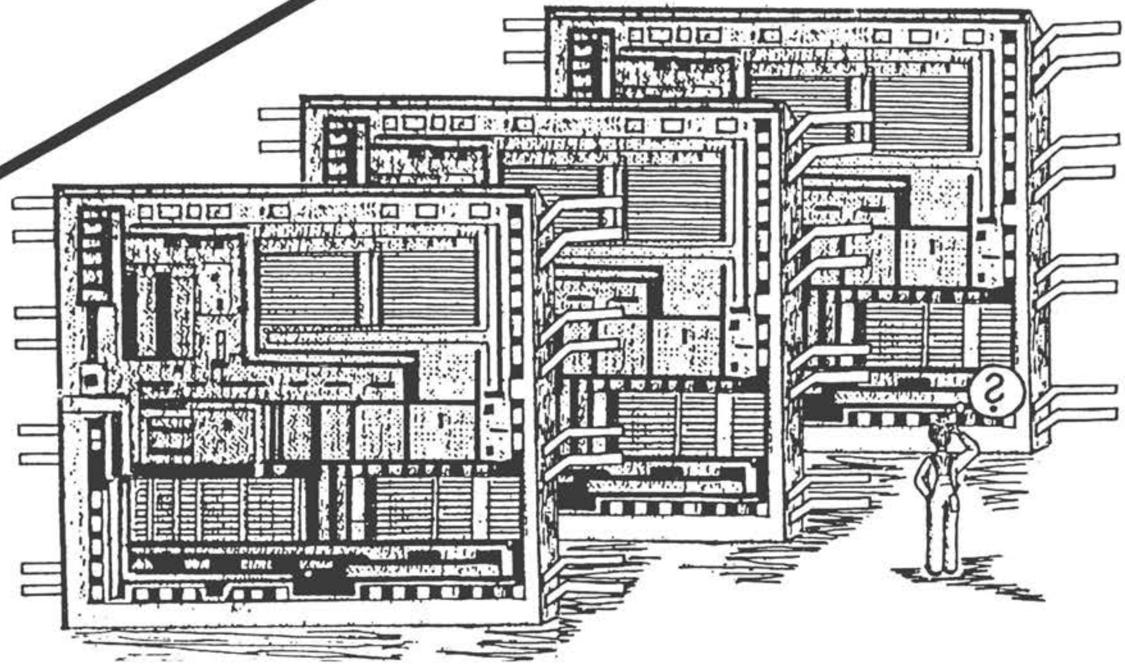

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