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PROGRAMME OF RESEARCH AND ACTIONS ON THE DEVELOPMENT OF THE LABOUR MARKET

MICRO-ELECTRONICS AND VOCATIONAL TRAINING IN THE EUROPEAN COMMUNITY

MAIN REPORT

By :

F. Christopher HAYES
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For :

Commission of the European Communities

Study n° 80/35

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Micro-Electronics and Vocational Training in the European Community.

Report by Chris Hayes Associates.

Summary

S1. The subject was first raised at the European Council in November 1979 and subsequently discussed by the Standing Committee on Employment in February 1980 and the Consultative Committee for Vocational Training in March 1980. This report is intended to contribute to a more detailed discussion of that Committee in July 1980. (Paras 1,2.)

S2. Most of the existing reports deal with employment in the sense of job losses which may result from the widespread introduction of micro-electronics; some explore its impact on different sectors of the economy. (Para 3.)

S3. Available forecasts are of limited use both because of the lack of data on current manpower stocks and shortfall, as well as the inability to define precisely a qualitative change before it has actually occurred. (Paras 4-6.)

S4. The report does not explain the technology of micro-electronics but only refers to its capacity to substitute intellectual activity and to its immense flexibility. (Paras 7-9.)

S5. The logic of the next steps of technological development mean that circumstances are now favouring a European initiative. The main accent should be on software, peripherals and application, although there should also be a European 'chip' manufacture. (Paras 10-13.)

S6. There is nothing automatic about such a development. To succeed, a European response needs a strategy in which manpower plays an integral part together with technological and financial measures. We have to understand the process of change in the demand for labour even though we cannot make accurate forecasts (Paras 14-16.)

S7. The penetration of micro-electronics has shifted emphasis onto more intangible qualities which are at present rarely considered as industrial or commercial skills. Annex 1 describes these qualities as they apply to the electronics industry itself. Traditional industries need to develop a capacity for expressing their demand in micro-electronic terms. (Paras 17-20.)

S8. Despite the immediate social repercussions of the introduction of micro-processors, in the long term we must anticipate much more basic and profound changes in occupational structure. (Paras 21-24.)

S9. Despite fears of polarisation, there is no basis for assuming an overall decline in skill utilisation or development. There is however, a shift in emphasis from the carrying out of tasks to performance monitoring. (Paras 25-27.)

S10. Occupational mobility has been an important factor contributing to American and Japanese success in adopting the new technology. However, an adequate education and training policy would encourage European participation while maintaining our social traditions. (Paras 28-30.)

S11. Training policies should be integrated in concept. In the short term they need to build up micro-electronic users' capacity for getting what they need. This needs to be reinforced by general adult information campaigns. (Paras 31-32.)

S12. More seriously many occupational profiles used for vocational education and training will lose their relevance because the occupations will have disappeared or changed out of all recognition. Serious planning for this process ought to start now. Meanwhile, secondary schools can take some immediate measures to familiarise young people with some outward aspects of the new technology. (Paras 33-35.)

S13. In the medium and longer term the new technology will reduce the distinctions between work skills and life skills and this will have important consequences on the aims of school. It will also clarify the division of responsibility between the public provision for education and training and employer responsibility for job specific training. (Paras 36, 37.)

S14. There will be varying effects on different sections of society. Opportunities for women should become much more equal. (Paras 38, 39.)

Micro-Electronics and Vocational Training in the European Community.

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Introduction

1. On 26 February 1980 the Standing Committee on Employment considered the communication from the Commission on "Employment and the New Micro-Electronic Technology"[1] which had been prepared in response to the discussion at the European Council in Dublin on 29 November 1979 and the Commission's paper "European Society faced with the challenge of New Information Technologies: A Community Response"[2].

2. In the paper on employment the Commission undertook to prepare, amongst other measures, a summary of the training requirements of the new technology based on an opinion of the Consultative Committee on Vocational Training. This Committee gave preliminary consideration to this question when it met on 19 March 1980 and agreed to a full discussion at its next meeting on 2-3 July 1980. This paper is intended to contribute to the debate.

3. Over the last few years a stream of official and commissioned reports as well as many private and academic studies have appeared in virtually all countries of the Community. We gladly acknowledge that some of the ideas expressed in this paper have been developed in sympathy with and drawn inspiration from these various reports[3]. They each tend to concentrate on specific aspects, either finance, technology or employment or on the social and broad

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[1] Commission of the European Communities COM (80) 16 final.

[2] Commission of the European Communities COM (79) 650 final.

[3] Annex 2 lists the most significant of these publications. However, more pragmatic analysis, based on action research, has in many cases not been published - (see para 31).

educational implications of micro-electronics. In the analyses of the impact on employment, the main attention has focused on work structures, and more especially on the possible loss of jobs. But the consequences for education and training, if they are considered in any detail, are seen to be adaptive, i.e. what kind of training is needed in order to facilitate the introduction of the new technology. However, it is in the nature of the far reaching technological changes that their detailed outcomes are difficult to predict and that, as a consequence, specific training requirements for employment growth cannot be accurately forecast - either in numbers or in specific competencies (qualifications).

4. This is because supply is always described in terms of the output of the formal education and training systems, whereas in practice, the existing occupational supply has come from internal labour markets, and the majority of entrants to DP work have already acquired their skills outside the education system*. Although estimates and projections at both the general and sector levels have been made, they are only reliable as a means to identify, rather than quantify, clearly impending imbalances; they can do no more than point to the direction in which remedial action will clearly be needed. More specific conclusions of shortage and surplus in an industry or occupation cannot be made without accurate data on the size of the existing manpower stock involved and current shortfalls. This evidence is not available in many countries.**

5. There is a further problem of forecasting in that much of the manpower required by the micro-electronics sector is but part of a bigger population of similar characteristics. The population of electronics/systems-based occupations is widely distributed across the computer and the electronics industries generally, and there are in addition sizeable

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* Annex 2, no 37.

** Annex 2, nos 10 and 37.

proportions employed in, for example, PTT Telecommunications, transportation, the armed-forces and academic and research institutions. This proliferation in demand from different industries will probably grow even wider with the increasing adoption of micro-processor technology, but the pattern of manpower utilisation by these and other "new user" sectors, and their key personnel needs are as yet impossible to identify.

6. We have therefore described in some detail* the skills and competencies now required by the new technology, but which are also becoming increasingly significant both as a component in other occupational profiles and also as the characteristics of newly emerging jobs in the changing structure of employment. They can be seen as a step towards a definition of the learning objectives by which existing training in the electronics industry could be measured, but also because they indicate the extent to which we shall have to modify our perceptions of deskilling (dequalification) and recognise the value at work of competencies which have traditionally been more closely associated with activities outside employment. The central feature of this 'new' skill of process-operating, at all levels, is decision-making.

The Significance of Micro-Electronics

7. There are some excellent summaries on the nature of the new technology, the structure of the electronics industry and the range of its applications+. It should therefore be sufficient to refer here only to a few salient implications of this particular advance in technology.

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*See Annex 1 to this paper.

+For example, see Annex 2, nos 1, 31.

8. Micro-electronics is part of the process of evolution in computer technology. However, while previous patterns of development can be seen as having extended the application of the physical functions of the human body, the emphasis of this new technology is as a substitution of intellectual activity. It is not that new machines have been invented, but the fact that brains can now be added onto existing machines that is so important. As it is a technology of control, it can be used in all situations where the transmission, creation and processing of data are required, whether this takes place as a physical or a mental process. It is precisely because micro-processors and micro-computers no longer need to operate in an exclusively numerical world that their impact will have increasingly pervasive social and intellectual effects (in a way similar to that once exerted by the small electric motor). The first paper on micro-processors ever published by IBM described the device as a "reconfigurable" circuit, significant because it could be tailored to fit any application simply by changing the software (or altering the programme). It is this flexibility, combined with a staggering cost reduction, that has generated its multiplier impact on a wide range of other technology, and so given a new dimension and significance to the overall structure of the labour force. The need to increase training in existing technologies in order to catch up with, utilise and maintain the advances that have been made possible with micro-processor technology is also essential for social and economic development.

9. Although this is not a technical paper on micro-electronics, it is important to understand both the present and future economic significance of the silicon chip. That its widespread introduction will make changes in job content inevitable is well known, but the lack of specific knowledge and information on the nature of these changes has generated a prevailing fear that the widespread introduction of the

new technology will gradually lead to both the deskilling of individuals and the disappearance of jobs, in the same way that industrialisation, while placing a new premium on the innovative and technical skills of those who designed and made machinery, fragmented the role of a craftsman into those of production operatives and machine minders*. The hostile atmosphere of this social response means that the training implications cannot be restricted to technical and economic analysis, and proper assessment must include an appreciation of various social and political dimensions which may well be acting as antagonistic forces. A manpower strategy must include a general programme of information and education designed to allay these fears and suspicions and to improve the status and the standing of micro-processor technology, and many journalists and other individuals have already begun such initiatives. More specifically, the requirements for education and training policy must be seen in two separate perspectives. There is the immediate and short-term implication of the festooning of existing equipment with micro-electronic components and the gradual substitution of electro-mechanical controls by micro-processor devices. Then there are the medium and long-term training needs for a labour market that has completely incorporated the micro-processor, whose characteristics we must anticipate even if we cannot predict.

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*This suspicion has been graphically described by Wassily Leontieff, the 1979 Nobel Prize economist. "To believe that workers replaced by machines will eventually find jobs in the construction of these same machines is equivalent to thinking that horses replaced by motor cars were able to find jobs in various branches of the auto industry."

A European Strategy

10. It is widely believed that the American and Japanese success in exploiting technological innovation can be explained at least in part by the initiatives taken by their governments to encourage the development and application of micro-electronics. It is also clear that the long term economic survival of the European countries depends on their ability to adapt to the new technology, and this has resulted both in "awareness" or "introduction" campaigns by governments anxious to promote industrial conversion. There are also demands from industry for better government training provision to alleviate the shortages of suitably skilled and qualified manpower. What is in doubt, however, is whether an individual response by each member country can be adequate to compete with American and Japanese domination of the industry.

11. It happens that several technical factors make this a particularly opportune moment for action on a European scale. It is now likely that the basic character of silicon chip fabrication - diffusion, ion implantation and photolithography - will continue to be used for the foreseeable future* and it has certain characteristics which are very clear:-

(i) levels of integration will continue to pack still higher densities onto the chip;

(ii) manufacturing equipment, especially electrobeam lithography, will become more expensive, making entry into production more capital intensive;

(iii) software will become more and more important.

*See Annex 2, no 39.

12. These characteristics mean that some of the advantages which used to be with the US, and to a lesser extent Japan, are now beginning to shift a little in Europe's favour.+

1. The relative dollar weakness has encouraged European acquisition through investment and funds of the financial scale required are now more easily available to the large European companies like Siemens or St. Gobain Pont-a-Mousson, or to those with government assistance like Inmos in the UK.

2. The main market pull now comes from telecommunications, teletext, energy supply and utilisation, office automation, automobiles etc., rather than almost exclusively from space, military and computers, and it is in these industries that European participation and world market shares are still significant.

3. With the main thrust of development now behind application, it is now becoming more important to keep design, manufacturing and marketing teams together, so the European tradition of stability is assuming some of the significance that used to be attached to mobility.

4. Software requirements are increasing, and Japanese and American companies have always relied extensively on European expertise in this field. It is often forgotten that, in contrast with the cost of the chips themselves, the software components and the sensors and actuators that make the micro-processors intelligent are rapidly rising in cost*. More and more chip suppliers are now beginning to provide standard modules of "solid-state software" to be strung together by the equipment manufacturers to suit the requirements of individual customers.

5. The novel requirements of micro-electronic applications also require extensive research into developing new high-level computer language and innovative machine

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*While the world electronics industry (estimated in 1979 to be worth $135 Bn) is now entirely dependent on chips, they account for less than 5% in value of its finished products.

+See Annex 2, no 40.

architecture. Both of these disciplines have been areas of European leadership and originality.

The potential status of European participation is therefore significant, and there are already indigenous manufacturers as well as several examples of joint venture and licence with US companies. Our present disadvantage of a late entry into the technology is not as great as it might be.

13. With all our national differences, the member countries of the Community remain closer to a European model than to that of either Japan or the US. We must develop a formula that enhances and exploits our slight technical strengths by emphasising our traditional superiority in application technology, although it remains important that we also become capable of producing and controlling our own supplies. It would be foolish to rely on the continuing availability of imported chips when their present manufacturers are experiencing a relative decline in profits. Although the techniques and methods of production are unlikely to change, the structure of the industry itself is bound to adapt to changing commercial circumstances. It is possible that the main semi-conductor houses will expand by vertical integration into systems supply - this has been the pattern of development in many more traditional sectors. However, it is equally possible that the electronics industry could respond to a demand similar to that experienced by the computer industry, by diversifying into areas of specialist client-orientated development, with emphasis on marketing and application skills.

14. It is crucial to realise that neither option in development is technologically inevitable, and that both are technically and financially feasible. But for Europe their implications are very different - if the electronics industry diversifies into specialist user-orientated application, European manufacturers and suppliers can probably compete in world markets and will be able to satisfy many of the domestic

market demands. However, vertical integration and systems standardisation by the large foreign manufacturers will limit our independence and compound many of our industrial weaknesses. Although the opportunity for exploiting European potential is greater than it has been previously, it would need a concerted European attempt to maximise this advantage, and the Community could perhaps play some part in supporting such action. We can only benefit from the new technology if we participate fully in determining the direction of its impact and development - we have to take the initiative to ensure that technological growth in Europe is symbiotic and not parasitic. To succeed, a European response needs a strategy in which manpower plays an integral part together with technological and financial measures.

15. There are two inter-related aspects to this strategy - the content of education and training and the timescale over which policies are deployed. The challenge presented by the micro-electronic 'revolution' requires a considerable development of our long-term education and training systems, which must be achieved without abandoning their underlying quality of continuity and their dependence on certain social values. Even though our response will not be training-led, education and training policy must be able to anticipate rather than simple react and the transition period presents problems of a different nature to those that will prevail in the longer term. We have to understand the substance of possible changes in the demand for labour sufficiently well to delineate accurate training objectives although we cannot measure or specify these requirements.

Changing Demands in the Labour Market

16. The electronics industry has its own new demands for specialist labour. But it is also significant as a new supplier of its products to the traditional manufacturing industries to whom it offers both alternative and new equipment components, as well as new products and components. These changes in the nature and the structure of production require new skills and will make others obsolescent, and there will be further changes in the structure of employment caused by the new information and control systems now being offered to both manufacturing and the service sector. Finally, there are new electronic products and services competing directly in the market, and although some of these consumer-orientated applications may seem trivial, they will have repercussions on the general education and awareness in society as a whole that will influence the impact of training policy. (See Table 1.)

The electronics industry

17. There are many complaints of chronic shortages of suitably skilled and qualified manpower at all levels within the electronics industry, but it is important to stress that these sorts of shortages are probably normal in a rapidly developing and innovative sector, and that most vocational training, to be successful, must still take place on the job*. This requirement however demands the recruitment of high calibre staff with good basic standards of general and vocational education, who can be deployed flexibly in a rapidly changing environment and respond to new demands from internal development as well as from new marketing

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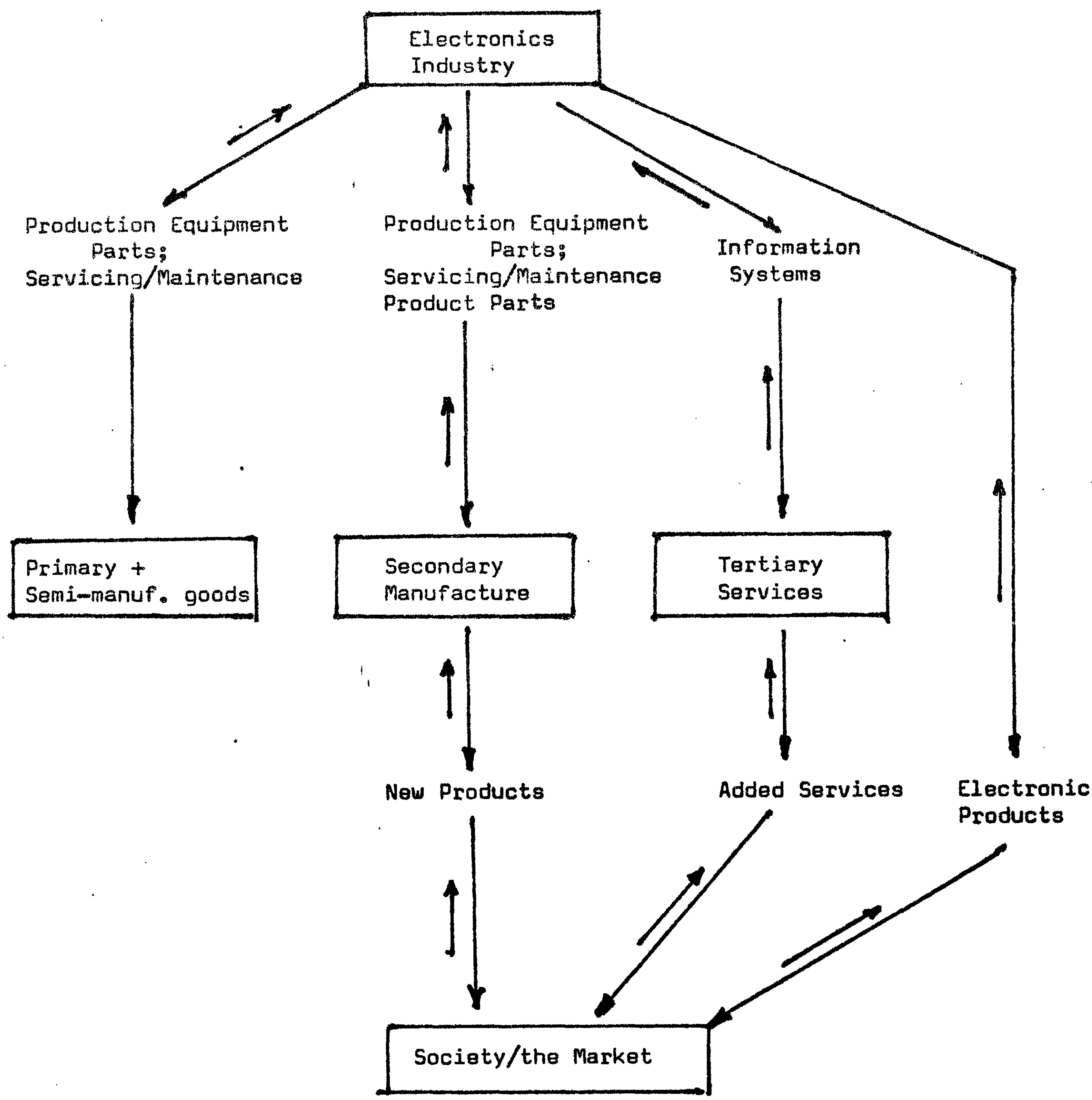
* A detailed and specific analysis of the existing structure of employment, and the skills and competencies now required in the various types of jobs, is available as Annex 1.

Table 1

Labour demand is affected by the relationship between the electronics industry and the primary, secondary and tertiary sectors as well as society/the market.



Work structures, job content and competencies* are affected by deliberate choices in the design and application of electronic systems.

*qualifications

opportunities; which means that training in the electronics, like other industries, will have to become concerned to a much greater extent with the external constraints in the labour market, i.e. the general level of education and competence from which appropriate skills can be developed as necessary. In fact, many of these competencies are very similar to those already required in the manufacture and design of traditional equipment and components, although the working environment and terminology is often very different*.

18. However, there is one new dimension of training in the electronics industry where failure has been conspicuous, and that is recognising the importance of organisation as well as information. Current systems design and analysis has focused attention only on the information flow to be automated while ignoring the structures, roles and job design that are the organisational mechanisms which execute and adjust these activities+. This weakness has been the source of many of the problems assoicated with computerisation**.

Traditional industry

19. For manufacturing industry there is the challenge of a new supplier, and in most cases the first impact of micro-processors will be as an option or alternative to existing resources and production methods. Their application in industry is likely to proceed piecemeal, with substitution of existing plant taking place as it becomes necessary or viable. Industry is already being offered new control mechanisms, new electronic components for established

*OpCit IMS (no 37).

+See Annex 2, no 21.

**See Annex 2, no 8.

products and new methods of maintenance. This means new and additional areas of knowledge and experience will be required by those responsible for purchasing and investment decisions. Employers will need designers who can see the use of, and who can incorporate electronic components; plant engineers who can use new equipment; and marketing departments capable of assessing potential demand and relating it to new opportunities. Although there is nothing new in this process of industrial adaptation, it is the scale and pervasiveness of the new technology which sets it apart from previous experience.

20. The teething problems of communication between the electronics industry and the rest of manufacturing industry - and in fact the tertiary sector - are rooted in a sort of credibility gap, and it is particularly important to educate industry, commerce and services in the ability to specify their needs in terms understood by those working in the electronics industry, or they will come to be dominated by it. Because the electronics industry has a desire to sell systems and hardware which has the largest market potential, buyers - unless they are from very large enterprises - will find themselves restricted to systems which have not been designed round the objectives of their organisation.* As a consequence these objectives may be perverted to meet the needs of the system. In particular, systems designers in the electronics industry are not usually concerned with the impact of their systems on their client's labour force. To meet this challenge needs training effort, extending to many levels of management and the workforce, to make it possible for enterprises to specify their requirements without having to rely on the advice of outsiders.

*For example, see Annex 2, no 21.

21. These changes in the demand for labour must be viewed in two different perspectives. In the longer term we must expect more basic and profound changes in occupational structure. In fact, a production environment that has assimilated the full impact of micro-electronics will be unrecognisable in terms of present occupational and labour market definitions. Moreover, the new goods and markets of such a structure will demand new services whose nature cannot be anticipated. But the problems of industrial adaptation will first have to be solved in the short term, and it is the immediate practical problems of transition that now present the real obstacles to adopting the new technology.

22. Although one of the startling characteristics of silicon technology has been its rapid development, the actual speed of its application has been consistently over-estimated. Like the national governments, individual companies assess their eagerness to be involved not only in terms of returns on investment but also with regard to internal concerns and labour problems - altering work systems has many other repercussions. Adaptive retraining is relatively easy, and is usually supplied by the new equipment manufacturers. But by changing skill requirements and indeed occupational categories, the new technology can present negotiators with potential disruption to existing pay structures - for example, establishing the differentials between secretaries, typing pool staff, word processing operators and telex operators. (In fact, as the proportion of labour costs continues to be reduced more radically, there will probably be an upward pull on wages - in an operation where downtime costs are prohibitive, rates of pay will become less important than the guarantee of continuity.) The source of the real problem, however, lies in the worker who has been made redundant.

23. Understanding the real nature of the long-term impact is difficult when unemployment is still defined in terms of industrial categories rather than occupational skill groupings. Questions of the changing structure as well as level of employment are intricately bound, and although there is no real agreement on the extent of the permanent employment effect,* these predictions have focused attention on what course of action is desirable to solve the problem of structural unemployment. The most common concern is that the impact of micro-electronics on manufacturing and tertiary sector employment is taking place at a time of severe conjunctural problems, of both structural and demand deficient unemployment that is likely to persist into the 1980's. The introduction of automation in the 1960's tended to be in growth industries, and because its introduction generated much additional administrative, clerical and technological effort, its adverse effect on numbers employed was often much smaller than originally feared - or hoped. But now firms are re-equipping to improve profit margins, without the prospect of rapid growth, and different types of increasingly sophisticated automation are displacing some highly skilled jobs - machine tool setting, draughtsmanship, colour matching, maintenance. However, it is in many of these areas that skills have already been in short supply for some time.

24. It is very important to stress that it is unrealistic to hope that the present tertiary sector will automatically absorb displaced labour. The service industry includes in fact a miscellany of jobs - banking, insurance, repair and distribution are all essentially part of the market economy, providing auxiliary services for industry and other productive sectors and are particularly vulnerable to micro-electronics. The rest - personal services such

*Annex 2, nos 31, 24, 29.

as catering and hotels, education, construction and medical care are less susceptible to labour shrinkage and it has been suggested that despite measures to curtail public investment, renewing expenditure in these fields may be an important part of employment policy.

25. Although there are many cases where an increasing need for auxiliary electronic education and experience represents a trend towards 'job enrichment' (double-metier) it is not clear to what extent this will also apply to many jobs below management levels. For some jobs, it is possible that operator practice will be confined to the 'gate-keepers' of a system which requires only minimal keyboard skills. Word processors are a well publicised and compelling example of this trend. Because terminals and other peripheral equipment used to be so expensive, only a small number of employees were trained to operate a limited number of terminals on a continuous basis. This usually meant that it was the most competent secretary/clerk who was made responsible for the keying functions of the new word processor, whatever consequences this may have had for her job satisfaction or the deterioration of her skills.

26. But although particular cases have caused legitimate concern about the potential for deskilling (dequalification), the socio-technical restraints on efficient performance and the design and structure of jobs will now require much more attention, and there is no real basis for assuming an overall decline in skill utilisation. In discussions about the polarisation of skills attention is often focused on traditional, technical or manual skills such as can be found in mechanical and electrical engineering, the construction industry and in some artisan occupations. It is implied that work tasks which do not require these conventional skills are therefore classified as unskilled (or semi-skilled),

the classic example being work on assembly lines. However, just as many white collar jobs demand competencies of a different kind from manual skills, so other more generally abstract competencies will play a significant part in operating the new technology. Just because the pace of work is not constant, and those employed on it do not appear busy, this does not imply its nature is less demanding nor its scope more restricted.

27. The impact of micro-electronics will have different effects in various sectors, and so on particular forms of work organisation and skills. Despite the trend towards vertical integration of the electronics manufacturers, and their initial success in end-product market penetration, they still have to rely on the expertise of manufacturers in developing applications - for example, toymakers have a sense for what makes a good toy which is denied to the semi-conductor houses. Even in those industries where the initial impact has been greatest, extensive industrial training will still be necessary to renew and maintain the competence and flexibility necessary for process rather than the more static occupational skills. This will mean a shift in emphasis from the carrying out of tasks to performance monitoring, with an increased need for multi-disciplinary working and interaction. In fact, the emerging occupational structure has been likened to that of an onion*, in which the bulge occurs at the middle level of skill, and this is more closely related to the normal distribution of abilities than is that of the pyramid. Job profiles will be subject to constant change which will require some changes in our notion of 'basic' education; what used to be seen as 'up-market' skills will now become necessary at almost all levels of employment - the ability to concentrate and attention to details have been specified as two such characteristics.

* P. Sadler, "Social Implications of Automation", I.Mech.E. Proceedings, Vol. 186 (12/72).

28. It is generally agreed that the new technology requires from the labour force a broader skill base and the ability to develop and learn new skills. This is in fact what is usually understood as 'occupational mobility', which seems to depend on two separate factors; both a general level of competence, and also the extent to which job related training enriches this basic level. In fact, occupational mobility is one of the main influences that affect manpower policy, because the extent to which labour supply and labour demand can be easily reconciled depends on occupational mobility (whether at the level of firm, industry or country). The extent of occupational mobility, in both internal and external labour markets, is itself a reflection of the national education and training system as well as the industrial relations climate. It is in fact possible to devise a philosophical spectrum within which one can identify the main emphasis of training policy. One end of the spectrum is market-orientated, representing technical or investment preoccupations, while the other end represents social and employment considerations. One's position on this spectrum is affected by the extent to which occupational mobility has allowed reconciliation of supply and demand. If general vocational training and job-related training are both of a high standard, training policy will be able to concentrate on advancing technical and investment aspects; if either job-related training or general education and competence is low, then occupational mobility will be limited, and training policy will have to concentrate on improving employment aspects. These factors can also be seen as determining the speed of actual innovation by enterprises as compared with the potential for innovation. There is a telling example of this analysis at the most general level of international comparison. In the United States there is an external labour market with high occupational mobility, and in Japan an internal labour market with high

occupational mobility; in both these countries technical and investment decisions are relatively little constrained by the social/employment aspects of technological development.

29. Although no technical system can be divorced from its social implications, there is plenty of evidence that technology is not the sole determinant in work organisation and that optimum investment must have both a social as well as a technical dimension to be effective. European fears of the employment effects of micro-electronic technology are part of our cultural background and rooted in our industrial infrastructure. They must therefore be acknowledged and incorporated within a manpower strategy, but they must be seen in their proper perspective - they are not intrinsic to the micro-processor itself. Manpower strategy as a whole will have to focus beyond the transition stage, despite the potential problems at this level. It is important to emphasise the scope of social and political action and control, rather than passive submission. And although occupational mobility in Europe is low, compared with either Japan or the United States, our traditions of a generalised education and training provide a mental flexibility that is already appropriate as a foundation, from which more job-specific skills necessary in micro-electronics can be developed and adapted.

Training Policies

30. This, necessarily brief, outline of the factors which should determine education and training policies shows that many of them combine to point towards specifically European responses. The next stage in technological development with its focus on application offers Europe some new advantages. The significant difference between European

and non-European countries lies in the character of our educational and social evolution and one of the key conclusions of this study is that only a strategy which takes full account of this from the very beginning can hope to maximise European opportunities. If this conclusion is accepted then there is a good case for the development of training policies which are concerted for the whole Community. Indeed, this may be the first case where external conditions point to the benefits of a pro-active joint European training strategy.

Short-Term Action

31. A consequence of government financial support to encourage the industrial development of a more specialist user-orientation (such as was indicated in para 14) rather than the large scale integration of electronics manufacturers and suppliers, would be a systematic training campaign in enterprises in the secondary and tertiary sector. The specifications for training programmes at various levels (including senior management and workers/employees representatives) could be prepared by a multi-disciplinary team, which could also be multi-national and which could draw on the extensive work already done in some Community countries*. The authors have encountered teams which included members with expertise in electronic engineering, computer science, vocational training, personnel management and trade union organisation. Their experience could make a suitable starting point.

32. In a similar vein governments should encourage more investment in, and wider availability of, PTT lines and more access to telecommunications. Such a development would involve extensive work on improving the compatibility of the various

* E.g. the multi-disciplinary team at the Copenhagen School of Economics and Business Administration.

national systems and as a result give considerable advantages of both size and sophistication to the European industry. The problems of reconciling electronic and electro-mechanical interfaces are a traditional European strength and an area of increasing technical importance to the industry as a whole.

33. More generally, industry sectors or, more likely, individual enterprises will cope with such on-the-job training as is necessary as a result of using micro-electronics. The relatively slow rate of absorbing new technology will make it possible to continue the use of well tried methods of training. Conversion training at work would become easier if it were supported by a greater general knowledge and understanding of computers. Distance learning for adults can become an important method for this purpose. In the Netherlands, for instance, 20 lessons on micro-computers were transmitted via TELEAC in the winter of 1978-79, whose purpose was to introduce the technical knowledge required to work with micro-computers to a broad audience. Over 14,000 viewers participated and completed the ancillary homework course.

34. A much more serious problem will arise, if not immediately, then certainly in the medium term, over the disappearance of boundaries between occupations and the subsequent breakdown of traditional occupational structures. A typical case has been the impact of the new technology on the newspaper printing industry. New Technology Agreements such as are advocated by the British T.U.C. and which are also practised in other European countries aim to regulate negotiations between employers and workers in a new situation. There have, however, been few signs of facing these problems in the structures of vocational education and training. In France one speaks of 'double metiers' because some knowledge of data processing

are being added to established occupations. In Germany some 'Berufsbilder' are being similarly amended and a new occupation 'Datenverarbeitungskaufmann' has been recognised since 1969. In the UK new ground has been broken in the training of programmers, most of whom lacked what were considered basic educational qualifications. But these measures are adaptive and do not do more than scratch the surface. The time has come when serious planning for new qualifications and competencies ought to start, planning which recognises that many established occupations may disappear or be changed almost out of all recognition.

35. The major impact on secondary education should be considered under the longer term repercussions but some help to cope with the more outward aspects of the new technology can be given to school children immediately. A good deal of work has already been done in all member countries, and many examples of good practice are available. They include the acquisition of keyboard skills, the recognition that, for work purposes, it is logic rather than mathematical ability that most of the labour force will require and the ability to handle binary arithmetic.

Medium and Longer Term Action

36. Despite the pressures to concentrate on alleviating short term problems, the longer term prognosis of successful adaptation is more optimistic, if more fundamental, and that is the real challenge to which a manpower strategy must respond. Decentralisation, made possible by the advantages of distribution as opposed to centralised processing, probably means a trend towards smaller independent

units instead of large time sharing systems, and this may be of more than a purely technical significance. This trend is not restricted to industries heavily dependent on data processing - group technology and cellular manufacture means that the economic benefits of large scale production are now being extended to the manufacturing of small batches. The impact of computer-aided manufacture will have extensive economic, social and environmental consequences. Such an economy would be characterised by increasingly capital intensive and automated production of what are in effect capital goods for the home, accompanied by an increasing proportion of final production being carried out at home.+ With the available technology it is already possible to convert some industrial and much office work into cottage industry. This development would further consolidate skills and competencies which are needed at work and at home. The objectives of vocational training and general education would become even more integrated and mutually dependent than they are now.

37. One of the shifts in skill patterns which will give work profiles a new look is the increasing importance of processes which cut across occupational boundaries. Another is the ascendance of more abstract competencies such as planning, communication skills, team work skills, persistence and attention to detail, at the expense of some of the more tangible skills*. Various other studies point to such qualities as coping with uncertainty; creative thinking; manual dexterity on a par with reading, writing and calculation skills; and most important the ability to learn by oneself. There has been an unspoken assumption that these qualities are acquired by a kind of osmosis, an unconscious process of assimilation. Schools are not in the habit of describing their learning objectives by quoting these qualities. They are concerned with knowledge; or

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+See Annex 2, no 28.

with the analysis of facts or events; or with the process of reaching a pre-determined solution. In spite of our long history of class room experience, formal and general education has not offered many learning opportunities which helped young people with more than the more superficial competencies needed for work and life. The new technology is reducing the distinction between work and life skills and it will be a painful but necessary task for secondary schools to embrace that perspective.

38. It would be overstating the case to conclude that <u>all</u> vocational training will become generalised in this way. On the contrary, the more we succeed in custom building systems for each enterprise and the more operations become decentralised, the more highly job specific training will be needed at each of the different levels of responsibility and action. Moreover, it will be impossible to obtain this training anywhere else but on-the-job. The interface between the training responsibilities of the community (the state or a local public body) and those of employers will gradually become more transparent and less ambiguous. Employers will have to bear the cost of job specific training and of much of the re-training which is needed for development. On the other hand a great deal of the initial broadly based vocational preparation and training will become a clear public duty and more under public control.

39. Finally, what will be the effect on our societies? The development of micro-electronic applications is unlikely of itself to redress polarisation, which is rooted in both social and geographical origins. But since the introduction of micro-processors will affect first and foremost the jobs with lower skill profiles, the opportunities of greater equality for women are likely to grow, despite the relatively high attrition

rate of jobs traditionally viewed as women's employment. The competencies required in the new types of jobs are culturally as accessible to women as to men and are less encumbered by social traditions and taboos. In fact, many of the qualities which have been traditionally disregarded as female abilities are now becoming useful assets, e.g. persistence, attention to detail, learning by doing etc., and devising and following a programming instruction has been likened to a knitting pattern. Most of the software houses already employ a high proportion of women in manufacturing.

40. In the space of this report is is only possible to raise some of the issues without a full discussion or documentation. A far more detailed treatment will be needed if action on any one or more of the issues is to be undertaken.

ANNEX 1 (Contributed by Rhiannon Chapman)

Analysis of skills required in jobs in the electronics industry

This description is not a definitive statement of all the skills necessary in electronics, but it is sufficiently detailed to show the shift in emphasis from techniques to process competence. It is probably still useful to list some of the more significant requirements for specific 'technical' competences, which form the basis for present employment in large sections of the electronics industry and they are listed as Section D. They are not invariably the stated requirement for all jobs; and the changing nature of the industry itself ensures that some of them will disappear, in time, and others take their place. In general, these competences are facile, and readily amenable to training/retraining. The ease of their renewal depends on the more fundamental skill base which must be developed as the foundation of jobs in micro-electronics manufacture and marketing and in Data Processing.

A. The design and manufacture of electronic components and equipment.

There are four main job groups in electronics manufacturing which account for between 60%-90% of all employment in electronics companies - the remaining functions are those performed in all companies; managerial, administrative, office, data processing etc.

i) Engineering

Both mechanical and electronic engineers are needed for R & D, design, quality control, manufacturing and sales support:-

- motivation to put new technologies to practical/profitable use;
- ability to analyse technical data in detail;
- a rational, logical approach to the organisation and interpretation of data;
- initiation of actions in response to the recognition of a problem area; and ability to follow-through own initiatives to an agreed conclusion;
- ability to work with and through others (normally not in a 'line' relationship);
- ability to communicate (in written and verbal mode, formally and informally), and to put across persuasive argument without baffling/antagonising/alienating audience;

- administration of budgets, time scales and other limited resources;
- documentation skills and discipline;
- appreciation of market needs and trends;
- creativity, able to take a 'challening' approach to problem-solving;
- sensitivity to the need to maintain a balance between technical excellence on the one hand, and cost, manufacturability and delivery time scales on the other;
- awareness of the social dimension to technical design, and recognition that therefore the optimum system is different from technical excellence.

ii) <u>Software</u>

Software design is still evolving as a discipline - it overlaps to a greater or lesser extent with hardware design activities, especially in the area known as systems engineering. Software specialists are usually paid and graded in the same structure as design engineers, rather than as data processing staff. As with engineers, as time goes by, more and more emphasis will be placed in the development of executive capability and market knowledge - in contrast to the current position, where they are largely seen as 'outside' the conventional organisation and merely providing a service to it:-

- orderly approach to the analysis of abstract/ conceptual problems (philosophical rather than mathematical);
- concentration on detail;
- ability to communicate with, and work in concert with, a small, highly interactive and possibly multi-disciplinary group;

- creativity combined with discipline (especially in the testing and documentation phases);
- understanding that socio-technical system and design are a factor in technical expertise.

iii) Technicians

These jobs cover a wide range of supporting technical roles, e.g. in documentation, provisioning, routine maintenance, fault-tracing and diagnostic testing, setting up experimental rigs, commissioning, implementing process changes, drafting, inspection, model making etc:-

- manipulative skills;
- ability to learn while doing, attain practical familiarity with the technology in its day-to-day application;
- methodical with detail;
- diagnosis interpretation of technical data and selection from a range of alternative technical responses;
- ability to tabulate and present information in graphical form, as well as basis, verbal and written reporting;
- ability to interact with engineers and to interpret their requirements in practical form; and with production staff, often in an advisory/supervisory/ training roles;
- ability to combine an interest in technology with a rigid adherence to established procedures and disciplines;
- some ability to anticipate non-routine problems, and undertake basic planning routines.

iv) Production operators

These are employed in a range of manufacturing activities, including new fields such as wafer fabrication and mask-making as well as the more common component sub-assembly and final assembly, inspection and testing. These tasks are mainly 'semi-skilled' and no formal apprenticeship is required, but performance and confidence continues to grow and develop with familiarity of the characteristics of plant process and materials. The central feature of this 'new' skill of process operating is decision-making, and although the routine may seem monotonous, downtime is extremely expensive and leads to periods of intensive activity:-

- dexterity with manipulation, e.g. of small components, wires; working to extremely fine parameters;
- use of microscopes;
- ability to work as member of a team (with engineer, technician, etc.);
- ability to appreciate importance of adherence to procedures, 'good housekeeping', cleanliness;
- adaptability to odd environments, e.g. 'clean' rooms, and use of unfamiliar terminology.

B. Customer Services

i) Service

Service technicians are now falling into two types -

a) Field Technicians, who have the customer contact, and lesser technical skills, apart from simple diagnosis (increasingly, done by 'black boxes'). Their skills and competence are basically the same as those required of technicians, but with less technical bias (unless working on prototype or highly sophisticated, custom-built equipment). There is one other particular skill

- ability to represent the equipment supplier, to the customer, on the customer's premises; assess the problem quickly and select from the range of possible technical and marketing responses available at the time.

b) Bench Technicians, who would do detailed fault diagnosis and repair at the supplier's base. Again, these jobs require the same skill as a technician, with one additional component

- ability to work on their own, or supervise a repair team, as required.

ii) Data collection/preparation

This is an area undergoing change - many clerks are now doing the collection and preparation themselves as part of their own job and activity, which includes direct access to a terminal. Specialist data collection clerks are now normally keyboard operators as opposed to punch operators, but would also have to prepare data on card, disk and tape media.

C. Data Processing

i) Systems Analysis

Increasingly, these are becoming business analysts, involved at senior, strategic levels in, e.g. business planning and organisation planning activities. Where the DP Manager once reported into the Company Secretary or Financial Controller, he/she now often has direct access to the Managing Director, either as a 'special relationship', or as a direct reporting line:-

- creative approach to the application of new technologies to the user's information systems;
- able to analyse functions in detail, and translate them into data processing terms;
- ability to recognise organisational needs and to initiate actions to enable the information/ data processing system to respond;
- ability to work with and through others (not normally in a 'line' relationship);
- able to communicate (in written and verbal mode, formally and informally), and to put across persuasive argument without baffling/antagonising/ alienating audience;
- quantification and administration of budgets, time-scales and other limited resources;
- high quality documentation skills and discipline;
- appreciation of developments in the market, trends, etc, and the ability to take these into account in system design;
- creativity - able to take a 'challening' approach to problem-solving;
- sensitivity to the impact of system design on the structure of jobs, skills, etc. in the organisation; and the ability to advise user management on this aspect.

ii) Programming

- numeracy to average secondary school level;
- ability to concentrate on laborious detail, in the translation of the programme specification into coded instructions;
- ability to select from a (limited) range of possible instructions, to give the most appropriate application to the programme specification;
- able to interact with systems analysts and other programmers in small groups.

iii) Operations

There is a significant difference in the jobs of Computer Operators in large installations compared to those in small. The former tend to function under Operating Systems (which are intended to improve the utilisation of the equipment by, e.g. queuing the jobs automatically, rather than depend on the operator to feed the jobs through). Some DP Managers feel that the OS uses so much computing power in itself, that any real gain in efficiency is arguable.

Small Installations:-

- ability to appreciate the general functions of the computer room and develop a familiarity with the equipment - monitoring, loading programme, queuing the jobs etc.;
- some (limited) diagnostic skills, when problems occur; such as to know what action to take in an emergency and save 'downtime' on the equipment;
- ability to maintain basic logs during the shift, and hand over effectively to the next shift;

- self-sufficiency, such that he/she can comfortably work alone in the somewhat 'sterile' environment of the computer room, for long stretches of time; maintaining awareness of the equipment's functions, without much need for involvement of activity.

Large Installations:-

Here the activities are so very much equipment-led, that the operator is required to do little other than be present to deal with any stoppages/emergencies. As this is invariably shiftwork, there is very little interaction with others; but the operator becomes accustomed to high earnings. DP Managers therefore usually ask for a fairly high level of academic attainment and potential leadership/programming/ systems analysis skills: because Operations cannot offer a worthwhile job, in the longer run, to the kind of people they want to attract. Because of the high turnover in this area, one of the 'competences' required of senior operators, is the ability to train others.

D. Technical Skills

- use of calculators;
- use of basic test equipment (Avos, analysers, oscilloscopes, etc.);
- drawing (with sufficient accuracy and detail to convey ideas);
- ability to read logic and circuit diagrams;
- ability to read computer code;
- familiarity with computer hardware;
- familiarity with keyboard;
- ability to manipulate controls;
- awareness of international standards, safety standards and local product liability laws;
- ability to operate standard machine-shop equipment;
- ability to operate inspection/measurement equipment (micrometers, guages, etc);
- awareness of process costs.

In Data Processing, it is important to draw the distinction between keyboard proficiency - as expected of a typist - and familiarity.

Analysts
- familiarity with computer processes;
- with VDUs, increasing need to use keyboard.

Programmers
- keyboard familiarity;
- appreciation of how Operating System works.

Operators
- keyboard familiarity;
- hardware familiarity.

ANNEX 2

We gladly acknowledge that many of the ideas expressed in this paper have been developed in sympathy with and drawn inspiration from the various reports which have already been published in different European countries. Some of the most relevant of these are listed below:

1. '<u>The Impact of Micro-Electronics on Employment in Western Europe in the 1980's</u>', European Trade Union Institute (Publisher: Günter Kopke, Brussels).

2. '<u>European Society faced with the challenge of new information technologies: a Community response</u>': (Commission of the European Communities, COM /79/ 650 final).

3. '<u>Micro-Electronics - a new dimension of technological change and automation</u>': G. Friedrichs, 1979 - a paper submitted to a FAST seminar at the Commission of the European Communities.

4. Papers submitted to the <u>Special Session on the impact of micro-electronics on productivity and employment</u>, Working Party on Information, Computer and Communications Policy, OECD 1979.

5. '<u>Employment and the new Micro-Electronic Technology</u>': Commission of the European Communities (COM /80/ 16 final).

6. '<u>Technical Change and Unemployment</u>', C. Freeman, OECD, January 1978.

7. '<u>Micro-Electronics, information technology and its effects on developing countries</u>', Dr. Juan F. Rada, July 1979, European Coordination Centre for Research and Documentation in Social Sciences, Vienna.

8. '<u>The Impact of Electronic Digital Technology on Traditional Job Profiles</u>', N. Bjørn-Andersen, Special Session on Impact of Micro-Electronics on Productivity and Employment (27-29 November, 1979), Information Systems Research Group, The Copenhagen School of Economics and Business Administration, Denmark.

9. '<u>Sociological Implications of Computer Systems</u>', Niels Bjørn-Andersen and Leif Bloch Rasmussen (Hugh Smith and Thomas Green, eds), Man-Computer Research, Academic Press, London 1980.

10. '<u>Auswirkungen einer breiten Einführung von Mikroprozessoren auf die Bildungs - und Berufsqualifizierungspolitik</u>', Battelle, Untersuchung im Auftrage des Bundesministers für Bildung und Wissenschaft, BF-R-63 868 / BMBW PO 11500.

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13. '<u>Micro-electronics: secondary and tertiary changes in technology and society</u>': E. Braun, K. Brunnstein, L. Emmerij, G. Friedrichs, A. King, 1979.

14. '<u>Incidences de l'introduction des machines a ecrire dotees d'une memoire sur les emplois de secretariat charges de dactylographie</u>', Centre d'etudes et de Recherches sur les Qualifcations, April 1977.

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16. 'L'information de la Société': D. Nora and A. Minc, Paris, La Documentation Francaise, 1978.

17. 'La micro-électronique menace-t-elle l'emploi?': Problèmes Economiques, Paris N° 1618, 1979.

18. 'Automation, travail et emploi': IRIS - Universite de Paris Dauphine 1979.

19. 'Informatique et Société: colloque international': papers from a colloquium organised by the French government in 1979.

20. 'Les emplois du secretàriat et les emplois de bureau connexes': N. Mandon, CEREQ, October 1979.

21. 'Microinformatics and Work Organisation - a case study': C. Ciborra, G. Gasbàrri and P. Maggiolini, Italy. Published in EuroMicro Journal, Vol.4 no 4, July 1978.

22. 'Maatschappelijke gevolgen van de Micro-Elektronica': Rapport van de adviesgroep Rathenau, Staatsuitgeverij.

23. 'The impact of chip technology on employment and the labour market': Metra Consulting for the Ministerie van Sociale Zaken, Netherlands 1979.

24. '<u>Final report on Technology Assessment of Computer Integrated Automatic Factory</u>': published by M.E. Merchant in CIRP Annals Vol. 25 (2) (1976).

25. '<u>Microcircuits, Society and Education</u>', W. Gosling, Council for Educational Technology for the United Kingdom, 1978.

26. '<u>The applications of Semiconductor Technology</u>', Advisory Council on Applied Research and Development, September 1978.

27. '<u>The micro-electronics revolution. A brief assessment of the industrial impact</u>', by Keith Dickson and John Marsh, Occasional paper - Technology Policy Unit - University of Aston in Birmingham, December 1978.

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29. '<u>What Microprocessors mean</u>', Michael J. Earl in Management Today, December 1978.

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33. '<u>Technological change and collective bargaining</u>', Association of Scientific, Technical and Managerial Staffs, London 1979.

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38. '<u>A new approach to training computer staff</u>', George Penny in Education and Training, February 1980.

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