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REPORT

drawn up on behalf of the Committee on Social Affairs and Employment

on the communications from the Commission on:

- technological change and social adjustment (COM(84) 6 final)

- vocational training and the new information technologies work programme 1985-1988 (COM(85) 167 final)

Rapporteur: Mr E. BROK

WG(VS)/2124E PE 98.518/fin.

By letter of 28 May 1985 the Committee on Social Affairs and Employment requested authorization to draw up a report on the communications from the Commission on: technological change and social adjustment and vocational training and the new information technologies work programme 1985-1988.

By letter of 26 June 1985 the Committee on Social Affairs and Employment was authorized to draw up a report on this subject. The Committee on Budgets was asked for an opinion.

On 18 December 1984 the committee appointed Mr BROK rapporteur.

At its meeting of 25/26 June 1985 the committee considered the draft report. The motion for a resolution as a whole was adopted on 19 September 1985 by 19 votes to 1 with 3 abstentions.

The following took part in the vote: Mr Welsh, chairman; Mrs Salisch, first vice-chairman; Mr Brok, rapporteur; Mrs d'Ancona, Mr Bachy, Mrs Banotti (deputizing for Mrs Maij-Weggen), Miss Brooks (deputizing for Sir Jack Stewart-Clark), Mr Chanterie, Mrs Chouraqui, Mr Christiansen, Mr Ciancaglini, Mr Fitzgerald, Mr Harlin, Mr Hahn (deputizing for Mr Gaibisso), Mr Hindley (deputizing for Mr Stewart), Mrs Larive-Groenendaal, Mrs Marinaro (deputizing for Mrs Hoffmann), Mrs Peus (deputizing for Mr Iodice), Mr Pininfarina, Mr Raggio, Mrs Squarcialupi (deputizing for Mr Alavanos), Mr Tuckman and Mr Vgenopoulos.

The opinion of the Committee on Budgets will be published separately.

The report was tabled on 24 September 1985.

The deadline for the tabling of amendments to this report appears in the draft agenda for the part-session at which it will be debated.

C O N T E N T S

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The Committee on Social Affairs and Employment hereby submits to the European Parliament the following motion for a resolution together with explanatory statement:

MOTION FOR A RESOLUTION

on the social aspects of technological change

The European Parliament,

- having regard to the communication from the Commission to the Council on technological change and social adjustment (COM(84) 6 final),

- having regard to the communication from the Commission to the Council on vocational training and the new information technologies - work programme 1985-1988 (COM(85) 167 final),

- having regard to the conclusions of the Council of 7 June 1984 relating to technological change and social adjustment[1],

- having regard to the communication from the Commission on employment and new microelectronic technology (COM(80) 16 final),

- having regard to the report of the Committee on Social Affairs and Employment on the repercussions of energy problems and technological development on the level of employment in the Community (Doc. 1-164/81) and the resolution of the European Parliament[2],

- having regard to the FAST programme,

- having regard to the resolutions of the European Parliament on
  - youth unemployment[3],
  - biotechnology[4],

- having regard to the communication from the Commission to the Council on new information technologies and the school systems in the European Community (COM(84) 722 final),

- having regard to the report of the Committee on Social Affairs and Employment and the opinion of the Committee on Budgets (Doc. A 2-97/85),

A. whereas the change in the general economic situation, growing pressure from competition, bottlenecks in the supplies of raw materials and energy and a growing awareness of the social consequences mean that technological change can now be accomplished less smoothly than in the past, and involves many unknown factors, particularly as regards employment,

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[1] OJ No. C 184, 11.7.1984, p. 1
[2] OJ No. C 260, 12.10.1981
[3] OJ No. C 153, 24.5.1983, p. 22 and OJ No. C 12, 14.1.85, p. 48 ff.
[4] OJ No. C 12, 14.1.1985, p. 139

B. whereas one of the most fundamental changes in the nature of the international economy and in society is taking place as a result of the introduction and rapid development of new technologies both in the workplace and in the home,

C. whereas technological change has plunged politicians, businessmen and the trad union movement into growing uncertainty as regards the future development of the existing social and economic order,

D. whereas if the European Community is to improve its competitive position and increase the prosperity of each of its Member States, it must dramatically increase its efforts, particularly in the fields of education, vocational training and retraining, to identify, prepare for and successfully meet the challenges of the new technologies, including biotechnology, robotics, telecommunications, research and development,

E. whereas the introduction of new technologies has led to the loss of employment in some industries; points out, however, that in 1981 some 900 000 workers in the EEC, Spain and Portugal were employed in the development of software and that an annual growth in employment of 10% is forecast for this sector by the early 1990s, leading to over 2 million jobs,

F. whereas, while the greatest scope for employment lies in the development of new technology products and services, it is further forecast that by the year 2000, a quarter of the population will be employed in types of activity which do not exist at present,

I. The importance of economic conditions for technological change

1. Stresses that technological change at the present time is not a smooth development but a dynamic process gaining ever more impetus so that, although the laws of nature remain constant, the ability of mankind to recognize and exploit them is opening up more and more new possibilities which in the past would have been thought Utopian;

2. Recognizes that research and innovation are key elements for economic growth, social equality, increasing earnings and prosperity, improving working conditions, maintaining international competitiveness and solving pressing ecological problems;

   (a) notes that both the production and sales markets for the bulk of technologically sophisticated goods are already dominated by US and Japanese firms and that threshold countries like South Korea and Singapore are making great headway, but believes that the Community could compete in the field of technology and that it would have positive effects on employment - particularly in the development of new products - if national governments and other public and private organizations would promote technological change as part of a joint action within a European technology community (e.g. EUREKA) rather than on a national basis,

(b) sees the risk of exacerbating the concentration of unemployment in those areas in which technological change has made limited progress; use must also be made of the Regional Fund in thee regions to modernize industrial structures and improve the infrastructure (also in the fields of training, universities and sciences),

(c) believes that the European Community must ensure that the needs of the smaller Member States, especially those in peripheral locations, are catered for in the area of new technologies, particularly where the structure for science and technology have not yet reached the comprehensive and sophisticated level of the more advanced Member States;

3. Recognizes that technological developments enable us to produce more wealth but may also create technology gaps between nations and regions as well as environmental pollution, impair the quality of working life and human contacts and reduce employment by rationalization;

4. Welcomes the Commission's intention to develop a Community strategy concerning technological change and social adjustment and calls for the presentation without delay of proposals for decision;

5. Notes that close interrelations exist between technological, economic and social developments which have to be taken into account if the effects of technological change are to be analysed and if technological change is to contribute to social progress;

6. Notes that decisions on the use of new technical processes are taken with regard to the supply of goods and services, the manpower available with certain qualifications, raw materials, infrastructure and capital investment and demand;

7. Stresses therefore that, disregarding the inherent momentum of technological change, it is developments on sales markets that determine the need for technological development;

8. Notes that competition on production markets and internal and external competition in substitution and imitation crucially affects companies' propensity to innovate and consequently the scale and rate of the adoption of technological changes;

9. Notes that price increases, employment bottlenecks and the requirements imposed by the state to protect the environment and agriculture force firms to make economic use of natural resources, to look for technical alternatives or to eliminate unprofitable manufacturing processes;

10. Believes that the knowledge available to deal with technological change, i.e. the ability of workers to learn and innovate as well as prior consultation and information of the workers concerned can contribute to greater international competitiveness of enterprises;

II. The effects on employment of technological and structural change

11. Notes that it is not primarily technical-organizational change which determines the loss of employment and that the causes of persistent high unemployment, apart from its demographic elements, have to be seen in too slow structural renewal of industry and in the neglect of product innovation, which does not mean that individual forms of technology do not destroy jobs, but simply that the situation is far more complex;

12. Recognizes that technological change plays an iportant part in maintaining the Community's competitiveness and safeguarding employment, if technology is also used to develop new products that meet changes in demand;

13. Notes, however, that the new technologies' employment-related implications are more serious for some categories of worker, e.g. women than for others;

14. Points out that at present it is difficult to predict the impact of new technologies on job creation in the short term; emphasizes that it is the 'new services' sector that may offer scope for job creation which would offset the job losses which have occurred in the industrial sector as a result of automation and rationalization;

15. Notes that the growth in productivity in those sectors characterized by an extensive use of new technologies has not been much different than in less technology-intensive sectors and that almost everywhere the development has been less pronounced than in the 60s;

16. Notes that structural change has been proceeding more slowly by comparison with the sixties, during which the manpower released by structural change found new employment in the growth-intensive industries:

(a) believing that the challenge of our time, unemployment, can be overcome by spreading and encouraging structural industrial transformation, taking account of the need for consultation among the social partners on such changes, rather than by hindering technological change;

(b) notes the serious disadvantages of internal barriers to trade for the development of the European industry in the field of new technologies, where it is most likely that employment will be created;

(c) draws attention to the need for unification of the internal market so as to benefit from the economies of scale and other advantages offered by a vast integrated market; also points out the importance of opening up public contracts and considers it vital that the Commission should continue its action in this field (e.g. the measures taken in the telecommunications sector);

(d) urges therefore the elimination of all obstacles to trade between the Member States and the creation of a genuine common internal market by 1992 at the latest, in accordance with proposals put forward in the Commission's white paper;

(e) calls therefore on the Governments of the Member States of the Community to adhere individually and collectively to their commitment to create a uniform internal market as expressed at the meeting of the European Council of March 1985 and as set out in detail by the Commission in its white paper on the completion of the internal market;

(f) urges that, by means of appropriate incentives, greater use should be made than in the past of the innovative capacity of, and the impetus to employment provided by, in particular, small and medium-sized undertakings in the Community and the establishment of new undertakings should be supported;

III. The new technologies - implications for the skills required of the work force

17. Points out that the labour market contains a wide variety of groups of people with differing occupational qualifications, so that even when supply and demand for labour correspond numerically, discrepancies between the level of occupational training of workers and the nature of the job vacancies available may make it impossible to match one to the other;

18. Notes that while technology provides people with additional products or services which would not be available without technology, it can at the same time replace human labour in the creation of goods and services (process innovation, rationalization);

19. Emphasizes also, however, that structural effects have done considerable damage to jobs in industry and that technological change has reinforced this process. In the technical professions, administrative, management, teaching and health professions, structural change, changes in organizational forms and the use of new technologies have led to an increase in employment;

20. Believes, therefore, that technological change affects the occupational qualifications required of workers and that, consequently, vocational training and appropriate measures to increase the provision thereof must automatically encompass all sections of the population, including women, in order to avoid narrowing options with regard to employment preferences;

21. Points out that the new qualitative features of human work, new types of activity and task and possibly higher qualification requirements are likely to be found in areas which are located upstream, downstream or in parallel to manufacturing as such and not with the employee working directly at the workbench;

22. Notes that additional qualifications are needed and must be acquired by workers as part of retraining schemes and by apprentices as part of their training programmes

(a) urges that women in particular should be involved in training courses and retraining measures in order to ensure that their occupational qualifications also meet the higher standards required by work with the new information and communications technologies and that they are not integrated solely into the simple stages of the technological process;

(b) recommends in the case of all Community measures and initiatives in the fields of vocational and further training, close coordination with the social partners and the chambers and specialist associations which exist in certain Member States;

(c) recognizes the importance of 'partnership programmes' between industry and higher education, training and research establishments tailored to local or regional needs, in order to expand high-level training and therefore urges the Community to play a major role in ensuring that high-level training is adapted to the changing needs of industry;

(d) draws attention once again in this context to the advantages of a dual vocational training in which company, professional and academic training measures are closely coordinated so that instruction in the use of technologies can be more geared to practice. Moreover the number of young unemployed is far lower in Community countries with alternating vocational training. The greatest problems are to be found in countries without a fully developed system of vocational training;

(e) agrees with the Commission that there should be appropriate publicity and general education measures in schools to reduce the anxiety and opposition to new technologies which are often based on ignorance;

(f) believes, therefore, that close links between schools and local industries, including the service sector, should be positively encouraged so that students and teachers can develop a real understanding of the role and training requirements of new technologies;

(g) believes that schools should be properly equipped and teachers and training personnel have the appropriate qualifications and modification to meet these new requirements;

(h) calls on undertakings to expand the further training of their work force in their mutual interest;

(i) urges the Commission to launch a series of demonstration programmes at Community level to increase awareness of and familiarity with the new technologies, both in schools and among the general public,

23. Doubts, however, whether the education system can act as a catalyst for technological change, as an institution to encourage or even accelerate innovations and wonders whether in fact short-term economic interests will not become the basis of educational policy;

24. Believes that basic tuition must be provided at school in information technologies along with conventional intellectual attainments (wider syllabuses);

25. Notes that it is more important at the level of general education for the development of the personality and given the rapid changes in qualifications required in the working world to offer people a broad education and to inculcate a communicative social behaviour which leads independently to posing questions, finding ideas, analysing problems, becoming integrated in a team and achieving a consensus therein. In vocational training and at university, specialization should not be at the expense of a broadly-based basic occupational training;

26. Considers that the education system should prepare people for ever-increasing periods of leisure;

27. Notes that changes in social communication can lead to problems. This is characterized by human relationships and the organizational structures and procedures which obtain within companies and outside companies at association level and in the field of politics;

(a) calls for support to be given to developments in new technologies that might improve the living conditions of the disabled and elderly and that usually take place in small and medium-sized undertakings;

(b) believes that in the health field new developments are of considerable benefit to mankind but that they must be applied in accordance with the principles of human dignity so that sick people are not put at the mercy of mechanized medicine;

(c) supports the Commission's efforts to press ahead with the development of health and safety standards as part of the Community action programme;

IV. The role of the social partners in technological change

28. Stresses that the timely provision of information and adequate consultation between management and workers' representatives both at plant, company and association level avoids social conflict and problems of acceptance and as a result stimulates and promotes on a lasting basis the forces of innovation in both the micro-economic and macro-economic sphere;

(a) points therefore to the need for a harmonious relationship of mutual trust between the two sides of industry during the technological transformation;

(b) calls on those involved in collective bargaining to conclude agreements to reduce the structural upheaval caused by the expansion of technological change by means of social measures;

(c) urges in particular, in line with the proposals of the European Parliament, that representatives of the workers should be informed and consulted, particularly in companies with complex transnational structures, on the introduction of technological changes and their effects at plant level and that the workers' representatives should be directly elected by secret ballot from the workers in the plant and calls for the implementation of the fifth directive on company law;

(d) calls on both sides involved in collective bargaining to conclude European and national framework agreements enabling labour and management to tackle jointly the consequences of technological change at factory and company level;

(e) calls on the Commission to prepare a directive relating to information, consultation and negotiation between labour and management about rationalization plans, working methods, production processes, health protection and safety at work with regard to the changes in the work environment brought about by the new technologies (a statute for a European company), with a view to establishing social partnership at factory and company level;

(f) welcomes, therefore, the fact that, on 7 June 1984, the Council decided to draw up - at Community level - a list of the principles common to the legal and contractual instruments in the Member States in the field of technology;

(g) takes the view that the use of new electronic techniques to supervise workers might prove degrading and hence a major problem and therefore considers that there is a need for appropriate agreements to protect workers and to inform them of the scope of such controls;

(h) believes that workers' and employers' representatives should receive special training;

V. The new technologies - implications for working hours, health and in terms of ethical considerations

29. Emphasizes that extensive information to the public on the opportunities and hazards involved in technical progress is needed to counteract the acceptance problems of social groups;

30. Points out that technical progress can offer mankind better protection against the forces of nature than hitherto and offer new scope for organizing its way of life;

31. Notes that the technical feasibility of cooperating over a great range and the fact that it is no longer necessary for all workers to be at their place of work at the same time releases production from rigid working hour arrangements, systems of working time and hours of business and thus allow options as regards the scale of work and output, timetabling, local working conditions and other aspects involved in the work process;

(a) believes, furthermore, studies are needed to gain information on the effects of remote working (via screens), for example on social insurance systems, living conditions including social contacts, health and safety, earnings structure, trade union links and the labour market;

(b) notes that evidence from surveys indicates that the majority of VDU operators experience some kind of health problems and recommends, therefore, that further work on the specific problems associated with VDUs should be carried out to determine what health and safety measures are needed in the future;

(c) believes that the technological transformation must result in a shortening and reform of working time, along different lines in different sectors and size of plant, subject to collective bargaining and the need to maintain international competitiveness;

(d) notes without wishing to ignore counter-examples that new technologies often lead to improvements in working conditions and therefore believes it necessary to collate and exchange at Community level examples of improved working conditions; believes also that it is at the level of research and development that the most important

work allowing new information technologies to contribute to an improvement in working conditions may be carried out, and recommends that at the design stage of large information technology systems, the implications for the quality of individual jobs should be taken into consideration;

(e) considers scientific monitoring of the use of new technologies to be essential in order to tackle new forms of mental and physical strain;

32. Stresses therefore that, subject to collective bargaining and the need to maintain international competitiveness, technological transformation enables working hours to be reduced and reformed;

33. Calls on the Commission to draw up a summary and comparative analysis of existing research work in the Member States on the effects of technological change and their impact on job creation in particular so as to guard against its negative effects; particular attention should be paid to investigating the impact in various social and personal spheres such as social relations, the labour market, the quality of work, education and training, ethics, personal life and safety;

34. Takes the view that ergonomic and human aspects should be included in research programmes, for example on office automation and production technology, that specialist personnel should be trained in ergonometry and the technical use of special (sectoral) applications and that questions relating to working conditions and new technology should form part of management training;

35. Takes the view that, despite its positive potential, genetic engineering raises grave ethical and social problems, that political and legal arrangements that take account of individual dignity must be devised and that the necessary definitions of the concepts involved should be drawn up in a dialogue involving politicans, scientists and social groups;

VI. Financial measures to eliminate any adverse effects of technological change

36. Endorses the Commission's aims of making systematic use of existing funds and financial instruments to control the social consequences of technological transformation and adapting their procedures accordingly and urges that research programmes on the new technologies and their uses and social effects should be formulated and adequately funded with participation by the social partners, academics and, in particular, the CEDEFOB in Berlin and the European Foundation for improving Living and Working Conditions in Dublin;

37. Urges therefore that the European Social Fund should receive additional finances as restructuring measures in industry call for a special effort to adjust new technologies so that the workers affected by the changes can be socially reintegrated, assisted and retrained;

38. Decides to commission a study on the subject of new technologies and their economic, industrial and social consequences on the lines of the Albert/Ball report and to use this study as the basis for a wide-ranging debate and decision-making process;

39. Urges that action be taken on the European Parliament's earlier calls contained in the 'European economic recovery plan' for the implementation of the objectives contained in the Commission's proposals and recommendations concerning the Community's industrial strategy, stressing once again that without an appropriate and innovative industrial policy the new technologies do not make full sense;

40. Believes that an effective environmental policy will lead to the development of new technologies and products and thus create employment;

41. Instructs its President to forward this resolution together with the report of the Committee on Social Affairs and Employment to the Council and the Commission.

B

EXPLANATORY STATEMENT

Effects of technological change

I. Introduction

There are close reciprocal links between technological, economic and social developments which need to be taken into account when analysing the effects of the technological transformation. Changes in the general economic situation, growing national and international pressure from competition, bottlenecks in the supply of raw materials and energy and a growing awareness of the social consequences now mean that technological change is taking place less smoothly than in the past and has plunged politicians and businessmen into growing uncertainty as to the future development of the present social and economic order. Even at the end of the 1960s, technological progress was seen as a means of increasing productivity and solving the problems of over-employment. But the persistent and marked unemployment and job insecurity as the consequence of years of weak growth rates, the excessively protracted structural adjustment to the change in circumstances, rising unemployment figures, particularly among those seeking employment after school, bankruptcies and direct experience of works closures have made the general public more sensitive. This effect was reinforced by the persistent neglect of environmental problems and the ecological consequences of economic growth, combined with the lack of alternative solutions once the problems became really urgent and could no longer be ignored. Thus the need for and expediency of technological innovation is being called into question more and more. Technological progress which in the past was generally accepted uncritically as the vehicle for prosperity now seems to many people to be the cause not only of growing problems on the labour market but also conflicts between the state and the people as reflected for example in the disputes concerning nuclear power.

This is also the reason why the social policy conflict between the two sides of industry has become far more intense over the last few years than in the past. The central issue in such conflicts was not so much an increase in earnings as the trades unions' demands for security of employment, protection against rationalization in various forms or an extension in leisure time by a reduction in working hours and longer holidays or rest periods. Employers too recognized the dangers from unemployment, particularly among young people, but found that profits were being squeezed by the economic recession so that the swiftest possible introduction of technological rationalization seemed advisable to improve the earnings position.

The two-edged effect of technological development now dominates the debate on the benefits or disadvantages of technological change:

- on the one hand research and innovation are key factors in economic growth, for increases in earnings and prosperity, for improving working conditions, maintaining international competitiveness and resolving urgent problems, such as those concerning the environment;

- on the other hand technological developments can create technology gaps between nations, regions or companies and pollution which impair the quality of working life and human contacts and reduce the number of jobs as a result of rationalization.

Thus the positive and negative effects of technological change are presented without the relative weighting of the effects being apparent. This is made all the more problematic by the fact that it is precisely the question of the labour market in the context of expanding the use of new technologies which is currently to the fore in economic and social policy.

II. The effects of modern technologies on employment

1. Effects of technological change on employment

1.1 Analytic and forecasting procedures to calculate the effects of technology

Sectoral estimates of the effects of technological change on employment in Europe produce totally contradictory results because such forecasts usually only filter certain data from the overall economic development and then seek to interpret these from a particular political standpoint. The following are a few examples of the large number of analyses and forecasts made to assess the impact of technology:

- In its report on the effects of technology, APEX (Association of Professional, Executive, Clerical and Computer Staff) claims that technology destroys more jobs in the United Kingdom than it creates. According to this study fifty jobs are lost for every new job created by new technology(1).

- The report drawn up by the Technology Policy Unit of the Western Midlands Council also concludes that by 1991 12 500 jobs could be lost in this area as a result of the introduction of robots. Most of the jobs lost would be in monotonous and threatened types of work(2).

- A different English study concludes that the technological change will have a positive effect on employment. It forecasts a loss of 340 000 jobs and a gain of 420 000 new jobs as a result of technological innovation(3).

  There is also a more favourable forecast of the effects on employment from Ireland. In its study, the Higher Education Society points out that the employment of graduates will increase(4).

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(1) The impact of office technology in the middle area, APEX, 1984

(2) Aston University, West Midlands Council, Social Europe, Commission of the European Community, March 1985

(3) Commission of the European Community, Social Europe, 1985

(4) First destination of Oneword receptions in Higher Education, Higher Education Society, 1982

- Studies carried out by the SYNTEC Association, the National Computing Center in the United Kingdom and software firms in the Netherlands also predict a demand for certain professional categories which cannot be satisfied by the labour market(1).

- Research carried out by the IAB/BIBB in Germany on the other hand in 12 000 selective firms in the metalworking industry for comparison with a similar study in 1973 shows that the new technologies have caused far more redundancies (34.7% of redundancies in 1979) than recruitment (16.2%).
  This study concludes that technological progress has a far more lasting effect on employment than the rationalization of existing investments so that the prospects for employment levels in future are not very rosy(2).

- A study of automation in 12 500 companies carried out by the Dutch Statistical Office(3) comes to very different conclusions. Overall the man-years worked rose from 40 150 (1979) to 48 750 (1981) and will rise to 59 000 in 1985. But growth is in inverse proportion to the number of employees.

- The IFO Institute for Economic Research (4) expects the productivity potential in manufacturing and the service sector in West Germany to increase considerably as a result of microelectronics and data processing. As production growth will level of in the '80s, however, the gap will widen between the trends in production and productivity which given the demographic background will tend to exacerbate problems on the labour market.

- The Prognoss/Mackintosh study on the effects of technological progress on the economy and the labour market in West Germany anticipates a virtually constant number of jobs until 1990 (1977: 24.9 million, 1990: 25.0 million)(5).

- This is also the conclusion reached in the study by the DIW (German Economic Research Institute). This shows the number of those in employment of 25.2 m in 1983 rising to 25.3 m in 1990, with the number of unemployed remaining almost constant (1983: 2.26 m, 1990: 2.29 m).

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(1) Social Europe, March 1985, No. 1/85, Commission of the European Communities, 1985

(2) Manfred Lanner, Auswirkungen technischer Anderungen in metallverarbeitenden Industriezweigen, 1979 in OJ No. 2/83

(3) Centraal Bureau voor de statistiek: Automatiseringsenquête, automatiseringspersoneelparticuliere Sektor 1981, The Hague 1983

(4) Technischer Fortschritt, Auswirkungen auf Wirtschafts- und Arbeitsmarkt, IFO-Institut fur Systemtechnik und Innovationsforschung/ISI - Frauenhofer Institut für Systemtechnik und Innovationsforschung/Infratest-Wirtschaftsforschung, Bonn 1982

(5) Technischer Fortschritt, Auswirkungen auf Wirtschafts- und Arbeitsmarkt, Prognoss AG/Mackintosh Consultants, Bonn 1981

- The RWI paints a more optimistic picture of the labour market. In its ex post analysis it shows that employment fell in West Germany between 1981 and 1983 by 857 000 because of structural effects whereas the technological transformation showed the postive balance of 650 000 new jobs(1).

- Prognoss AG reaches less favourable conclusions as regards the trend in employment in its study of the effects of technological change on the car industry in Hesse. Growing automation and the low rate of growth in private car manufacturing of 0.7 per year are likely to have led to 165 000 redundancies by 1975(2).

- The SOFFI Study also shows a drop in the level of employment in the automobile industry over the next few years(3).

- A study by the car industry in Flanders on the other hand showed that although world demand fell by 2% in 1982, the Belgian car industry was able to increase its share of the market by 14% due to its technological investments which meant that not only were jobs safeguarded but also new employment created(4).

- In its analysis, the Institute for Research into the Labour Market and Professions of the West German Department of Employment concludes that the use of numerically-controlled machine tools has had a positive effect on employment(5).

- The Institute for Economic Analysis headed by Wasily Leontief forecasts for the United States over 11 million jobs lost by 1990 and over 20 million by the year 2000 as a result of the effects of programmed work resources on the structure of production and employment and the influences of new technologies on investment behaviour combined with sharply rising rates of employment in the US in 1990 and 2000 compared with today(6).

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(1) Langfristige Perspektiven der wirtschaftlichen Entwicklung in der Bundesrepublik Deutschland, DIW, Deutsches Institut fur Wirtschaftsforschung, Berlin

(2) Soziale Auswirkungen des technischen Wandels in der Hessischen Automobilindustrie, Prognoss AG, Basle

(3) Das Ende der Arbeitsteilung-Rationalisierung der industriellen Produktion, Horst Stern/Michael Schumann, SOFFI, Gottingen, 1982

(4) Neue Technologien: Befreiung oder Versklavung; Conference of the Konrad Adenauer Foundation, Brussels, March 1985

(5) Beschaftigungsveranderungen bei Einsatz numerisch gesteuerter Werkzeugmaschinen, Institut fur Arbeitsmarkt- und Berufsforschung der Bundesanstalt fur Arbeit, Nurnberg, 1982

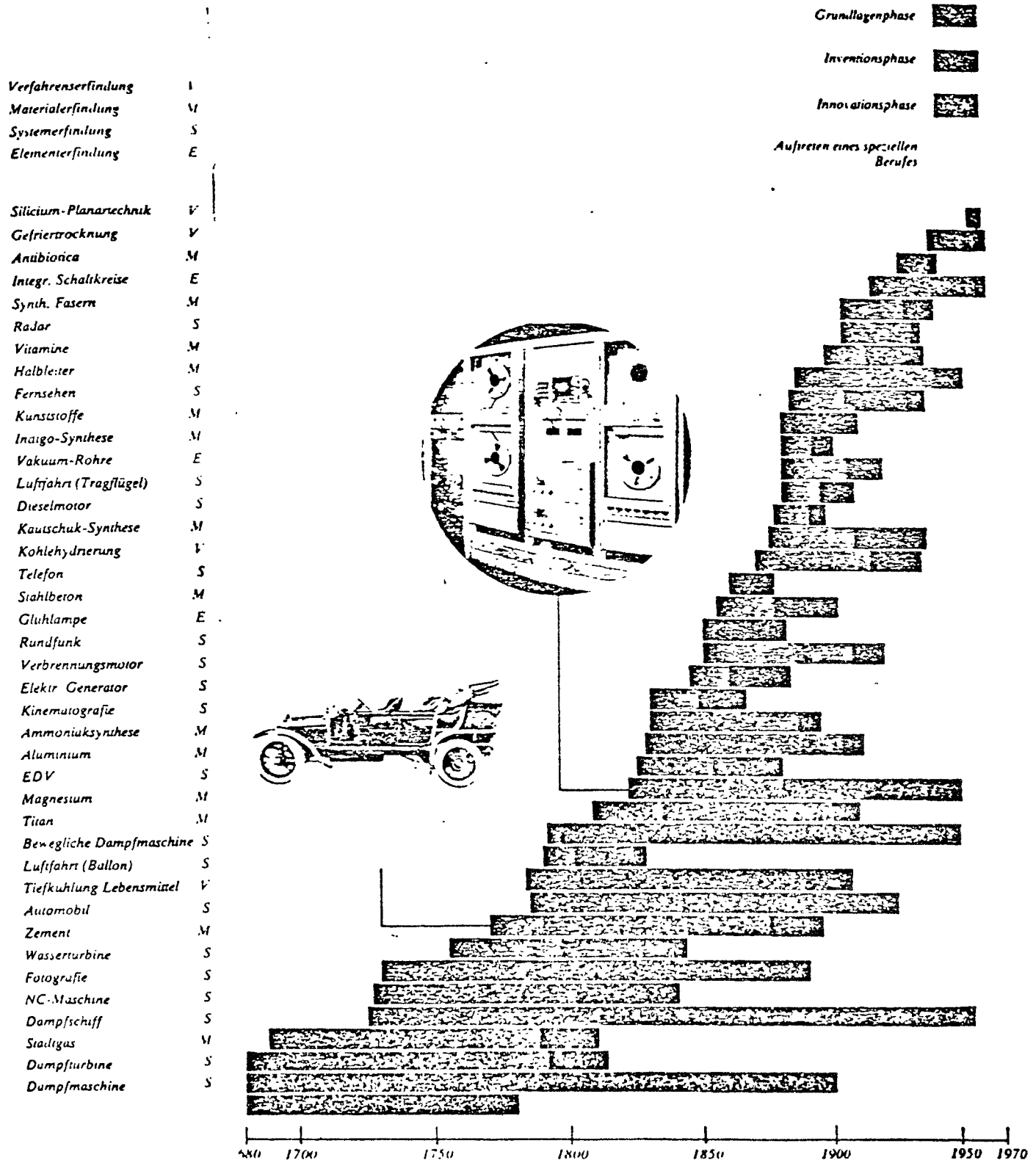
(6) The impact of automation on employment 1936 to 2000, Institute for Economic Analysis, New York, 1984

- The DIRF set up by the Flemish Government in 1982 has considered the reciprocal effects of technology and society. According to the DIRF, although technological change leads to a loss of jobs at the micro-economic level, it sets off a development at the macro-economic level which not only eases the pressure on the labour market because firms increase capacity but also because increased competitiveness enables firms to increase their share of the market and thus create new employment.

1.2 Historical development

Work is the basis for every human society and the most striking difference from animals because the work of man is deliberate and purposeful. A division of labour between people took place at an early stage. In the course of human history this division of labour has become increasingly more sophisticated and technical aids have accompanied the process. The areas of work were, however, still dictated by nature. Output was determined more by natural features than by the quantity or quality of labour input. The dawning of the industrial society, however, created new structures of work. The invention of the steam engine, for example, created

a central source of human labour independent of natural features but which at the same time formed the core for an agglomeration of workplaces and processing machinery. This was the beginning of the industrial revolution known as the first industrial revolution. Although there is a certain amount of controversy concerning the details of the industrial revolution, it is, however, usual to describe as the first industrial revolution the reinforcement of human labour by machines which beginning in England spread to the whole of Europe at the end of the 18th century as a result of the introduction of the steam engine and special machinery, particularly in the textiles industry.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Materialerfindung M
Systemerfindung S
Elementerfindung E
Silicium-Planartechnik V
Gefriertrocknung V
Antibiotica M
Integr. Schaltkreise E
Synth. Fasern M
Radar S
Vitamine M
Halbleiter M
Fernsehen S
Kunststoffe M
Indigo-Synthese M
Vakuum-Rohre E
Luftfahrt (Tragflügel) S
Dieselmotor S
Kautschuk-Synthese M
Kohlehydrierung V
Telefon S
Stahlbeton M
Glühlampe E
Rundfunk S
Verbrennungsmotor S
Elektr. Generator S
Kinematografie S
Ammoniuksynthese M
Aluminium M
EDV S
Magnesium M
Titan M
Bewegliche Dampfmaschine S
Luftfahrt (Ballon) S
Tiefkühlung Lebensmittel V
Automobil S
Zement M
Wasserturbine S
Fotografie S
NC-Maschine S
Dampfschiff S
Stadtgas M
Dampfturbine S
Dampfmaschine S
1700
1750
1800
1850
1900
1950
1970

The second industrial revolution is the period following the general introduction of independently controlled machines which then no longer required human operators. Some authors, however, define this period by reference to specific technologies such as electricity, the combustion engine or the innovations of industrial chemistry. Technological developments meant that human labour shifted away from actual processing into the fields of supervision and control of production. In addition to the increased distance in time and space, the formation of associated activities (planning, construction, commissioning, maintenance and repairs) led to new forms of work. This phase which was triggered by microelectronics in data processing has recently come to be described as the third industrial revolution. The human thought processes needed at the place of work can now partly be replaced by artificial intelligence provided by machines.

Technological change includes changes to technology itself and its applications. Given the close inter-relationship between technology and all categories of human and natural existence, however, it is almost impossible to make a clear distinction. Thus technology cannot be defined only described. Normally this takes the form of a generalized description of technical products and services, consideration of the historical development of technologies and subclassifications of technology according to their areas of application or research. Given the complexity of technical systems, however, it is important to adopt a systematic approach to technology and technological change. The following categories represent a rough classification of the technological change currently in progress where in some cases the applications and development are still at a very early stage.

Biotechnology

Biotechnology can be further broken down into microbiology, biochemistry and process technology. In this key technology where the rate of progress is hectic, biochemical, microbiological and process technological methods are used to manipulate the potential of micro-organisms, cell and tissue culture. Food, drinks, medicines, biological pesticides and raw materials are produced; new forms of micro-organism are being bred to purify water and utitlize waste. Other pioneering methods include the culture of tissue cell outside the organism (cell culture technology), fusion of cells with different properties (cell fusion technology) and enzyme technology (biosynthesis and separation processes).

Energy technology

Promising techniques which offer the prospect of safeguarding the supply of energy include above all energy utilization techniques (long-range heating, combined heat-power, heat pumps). Coal beneficiation (gasification and liquefaction) is a further important way of using domestic resources. New combustion techniques can help prevent harmful materials being produced in thermal power-stations. One of the most promising of the alternative energy technologies is photovoltaism, the direct conversion of sunlight into electric power using silicium cells. Nuclear fusion (fusion instead of the fission of atoms currently used in nuclear power-stations) is a further example of energy technology.

Manufacturing technology

In this field, the structural transformation is only just beginning. Conveyor belts and arduous forms of labour are being replaced by robots. They are moving workers in manufacturing away from the factory floor into the offices. Computer-aided design and construction systems, combined with computer-controlled manufacturing systems which can then produce even small numbers of items are becoming the new features of manufacturing.

Genetic engineering

Using enzymes, the carriers of genetic information in the cell, the molecules of deoxyribonucleic acid (DNS) are dissected and reformed using lyases. Introduced into a cell the DNS recombinant can produce new properties. The area of application of this technology is very wide but the inherent risks and opportunities have still to be assessed. In the health field genetic engineering is being used to produce interferon to combat cancer, human insulin, vaccines and medicaments. The most important potential area for using genetic engineering in the long term, however, is agriculture, for example to produce new plants to provide food in underdeveloped regions and for nitrogen fixation.

Information science

The greatest changes in society and business in the foreseeable future are likely to come from industrial developments in the field of electronic components in microelectronic systems, technical communication, home entertainemnt, data processing and office technology which lead to changes in organizations and documentation by electronic word processing and interactive computer systems and industrial automation which makes it possible for the operation and supervision of the manufacturing process by automatic devices. Microelectronics plays a particularly important part in this. In future it will extend to new areas of use for electronics and encompass a wide range of control functions.

Laser technology

Lasers, intense beams of coherent radiation, are used in almost every field of research and technology, to transmit information, to work materials, in measurement technology, physics, chemistry, biology and surgery.

Materials science

Materials science is attracting increasing attention as a technology of the future: structural ceramics, powder metallurgy, composite materials and high-temperature metallic materials. Considerable innovation potential lies in materials on a plastics base, polymer materials, which can also be used as semi-conductor materials in electronics.

Space technology

Space laboratories and space stations offer new opportunities for research, technology and industry. In almost complete weightlessness, new materials can be produced such as purest silicium crystals for semiconductor components and medicaments. Satellites transmit information, explore the earth's surface and provide meteorological and navigational information.

2. The importance of the economic situation for technological change

Technological change does not proceed at an even pace but interacts closely with social and economic conditions to develop into a dynamic and ever accelerating process. Technological change can therefore only be analysed against the background of the circumstances which condition it.

2.1 Economically relevant conditions

Technical changes have led, and are continuing to lead, to structural changes which present existing structures with problems of adaptation to the changes in technical or other features. The background conditions and, the pressures of economic decisions consequently are a major factor alongside social effects on the adjustment and speed of scientific change. First of all finance must be forthcoming for technological change without there being any direct benefit. Both in micro-economic and macro-economic terms, technical investments can only produce yields in the fusion phase of a technical development. Technological change can only take place if a part of the national product is used for this purpose. Decisions on the use of new technical processes are taken having regard to the supply of goods and services and the qualified staff available, raw materials, infrastructures and capital investment. In a social market economy, decisions on production are then taken by private companies supplying goods and services, and the state agencies and non-profit-making organizations providing public services. There will only be a willingness to use and develop technical changes if private companies or state and other agencies see any benefit to be derived either in the form of greater and more lasting economy and cost effectiveness or more satisfactory achievement of tasks and greater stability. In macro-economics, the influences of technical features are always included by economists in the production function as the residual factor 'technical progress'. Its importance fluctuates considerably according to economic needs and intentions. In micro-economics on the other hand, technological change is dealt with in far greater detail and more specifically than in macro-economics, it receives far more factors than simply a given form of specialized technology. It is included in micro-economic production equation under the concept of innovation, a technically defined influence which takes place at plant level.

2.2. Development on sales markets

2.2.1 Shifts in supply and demand

The drop in population and stagnation of private households combined with consumers' high level of prosperity and acquisition and demand for better quality has meant that the sales markets in most sectors of the economy have clearly developed towards buyers' markets. Consumers are becoming more discriminating and products cannot be sold as easily as in the past:

- Non-durable products in the food and textiles sector are consequently experiencing a decline in growth rates with a tendency towards stagnation,

- Basic durables are showing signs of saturation with negative growth rates in terms of sales volume and a marked trend towards high quality products,

- Products and services which satisfy special wishes of individual customers on the other hand are selling well despite price increases. This change in consumption patterns in traditional markets is now producing a marked shift of emphasis in development and demand for technical skills:

- Mass products, the vehicles of growth in the '60s, are becoming less important,

- Success depends on improving quality, product innovation and extreme flexibility of production plant,

- High sales and counselling services are increasingly becoming the key features of business profitability.

2.2.2 New markets

These trends on the old markets are being partly augmented and partly reinforced by the emergence of new markets. The greater the amount of leisure time and disposal income available, the greater the demand for goods and services in the leisure-time sector, although the earlier trend towards transport, tourism and leisure items is moving towards information, education, advisory and care services.

The trend towards labour-saving rationalization in the home, business and public sector is being reinforced by the under-utilization of capacity and pressure from costs. The quality and quantity of social communication is becoming more important in companies, schools, administration and politics in the light of growing specialization and division of labour. This produces an additional market for the appropriate services and related products (for example audio-visual media). The growing awareness of the scarcity of raw materials and energy and threat to the environment offers favourable sales prospects to suppliers of equipment and plant to save on energy and raw materials and reduce pollution. Improvements to physical and psychological living conditions also offers opportunities to the suppliers of products and services better adapted to human beings and promoting health.

2.2.3 Effects on sectors of the economy and the need for technical solutions

Changes in sales prospects make investment essential

- the less the domestic supplies of a sector of the economy grow in real terms in comparison to the overall economy,

- the fewer new sales possibilities can be found to compensate for drops in sales and

- the less possible it is to fall back to smaller specialist markets because of product differentiation within a given sector.

Under the different market circumstances in the past, those technical solutions and innovations were successful which enabled rapid growth in the volume of production, often with an increase in capital commitment.

Price and cost gains were made by economies of scale and the emphasis was on supplying the market. The shift in market conditions means that now the most successful technologies are those which allow adjustment to structural shifts in demand with the relatively constant volume of production, i.e. high flexibility of plant, low conversion costs and smaller optimal production runs and which also reduce manpower and infrastructure requirements without a loss of quality. The trend in rationalization and technological development is clearly shifting away from large-scale to flexible manufacturing plant.

2.3 The situation as regards competition

Competition on production markets and competition from substitution and imitation both internally and externally produce considerable pressure for innovation on companies and thus influence the scale and rate of the adoption of technological change.

2.4. The effects of the shortage of resources

Price increases, employment bottlenecks and legislation to protect the environment and agriculture are also forcing companies to make economical use of natural resources, to look for technical alternatives or to eliminate unprofitable production processes. The knowledge available to deal with technological change, i.e. the willingness of workers and employers to learn, innovate and reach consensus will be important in international trade.

2.5. The influence of state quality standards and production controls

State quality standards and production controls with general requirements geared to social policy objectives may either help or hinder the search for new technical solutions although bureaucratic approval procedures make innovation more difficult.

2.6. The influence of changes in general economic conditions

These general economic conditions have more effect on the willingness to innovate than innovation itself.

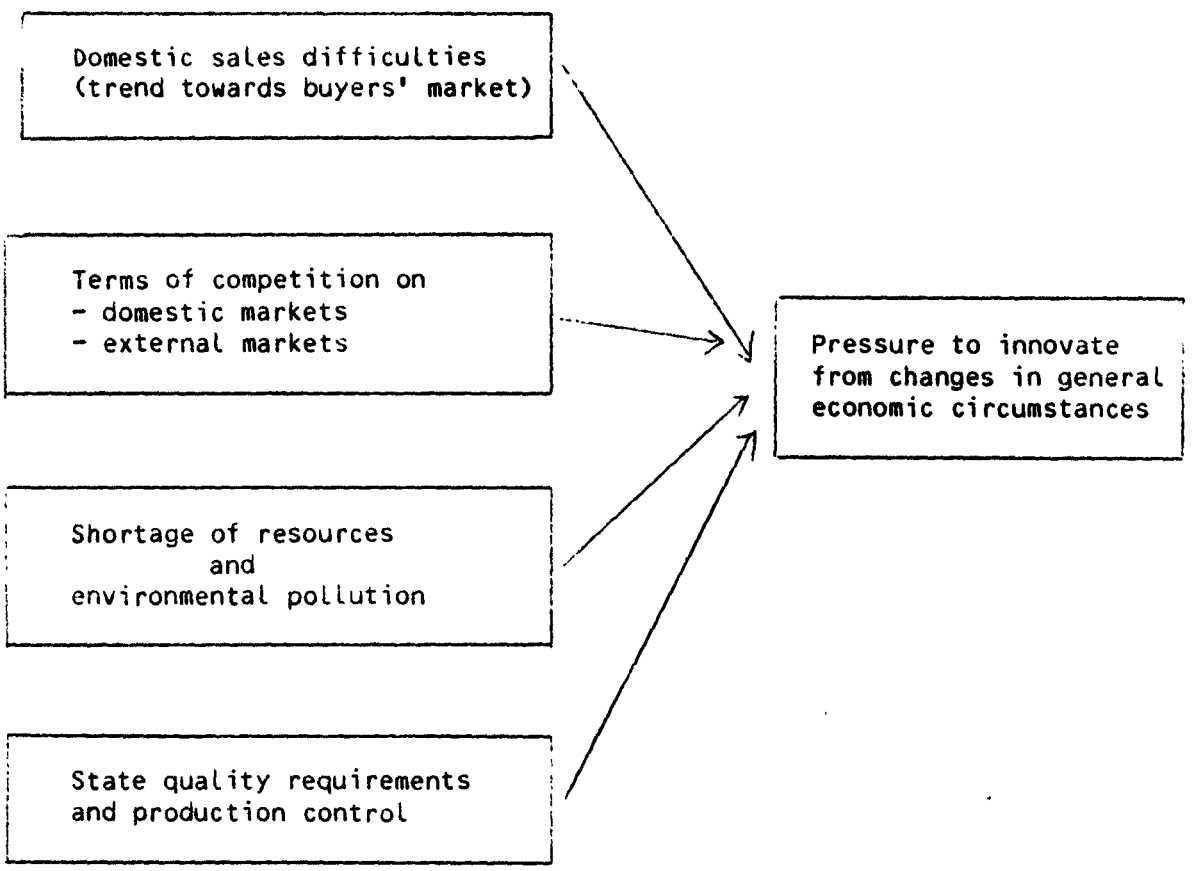
- Sales or profitability problems in companies and an accretion of tasks or reduction in finance in non-profit-making organizations may involve different strategies:

- Cost saving by applying process innovations (rationalization)

- Abandoning hitherto successful products/ranges to concentrate on more profitable products or products with heavier demand (streamlining or avoidance strategy)

- Expansion of product/range by product innovations to gain financial room for manoeuvre (diversification strategy).

Figure 1 shows the overall pattern of pressure to innovate based on shifts in general economic circumstances in the individual sectors of the economy.



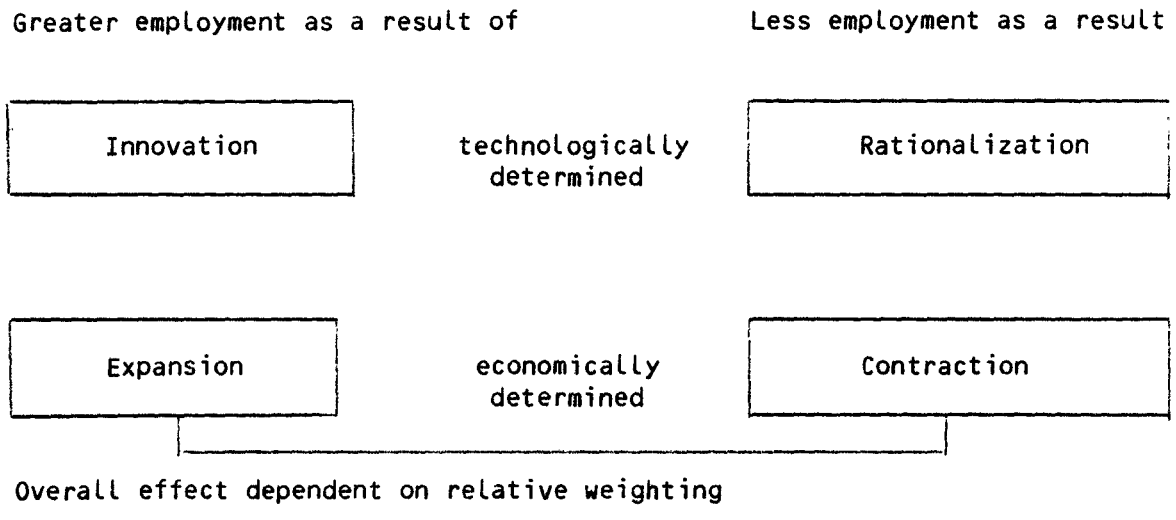
2.7 Quantitative shifts in employment

Demand for manpower is closely related to these factors. Over the last few years growth has been so minimal that demand for manpower has declined sharply. There are no figures to support the assertion that the present shortfall in employment is not particularly critical because the problem will solve itself at the end of the decade with a drop in population; a drop in population implies moreover a drop in demand. As a result the problem of unemployment will be no easier to solve in the long term.

The existing manpower reserves should not however be seen in global terms because the labour market does not include a homogeneous supply of manpower but a large number of different groups of people. The main criteria for classifying this reserve are sex, age, regional structure and qualifications. Even if supply and demand correspond numerically, structural discrepancies may nevertheless produce disequilibrium. There is no one single reason why demand for manpower is at present so low compared with the reserves available. Certainly technological change alone is not responsible for unemployment. On the contrary, technological developments have triggered massive areas of growth which are largely creating the employment available today. If one looks more closely at the relationship between technological change and employment while having regard to general economic conditions, there are two aspects of its effect on employment:

- technology provides people with additional products or services which without it would not exist (product innovation, new products),
- technology replaces manpower to produce goods and services (process innovation, rationalization).

Quantitative shifts in employment



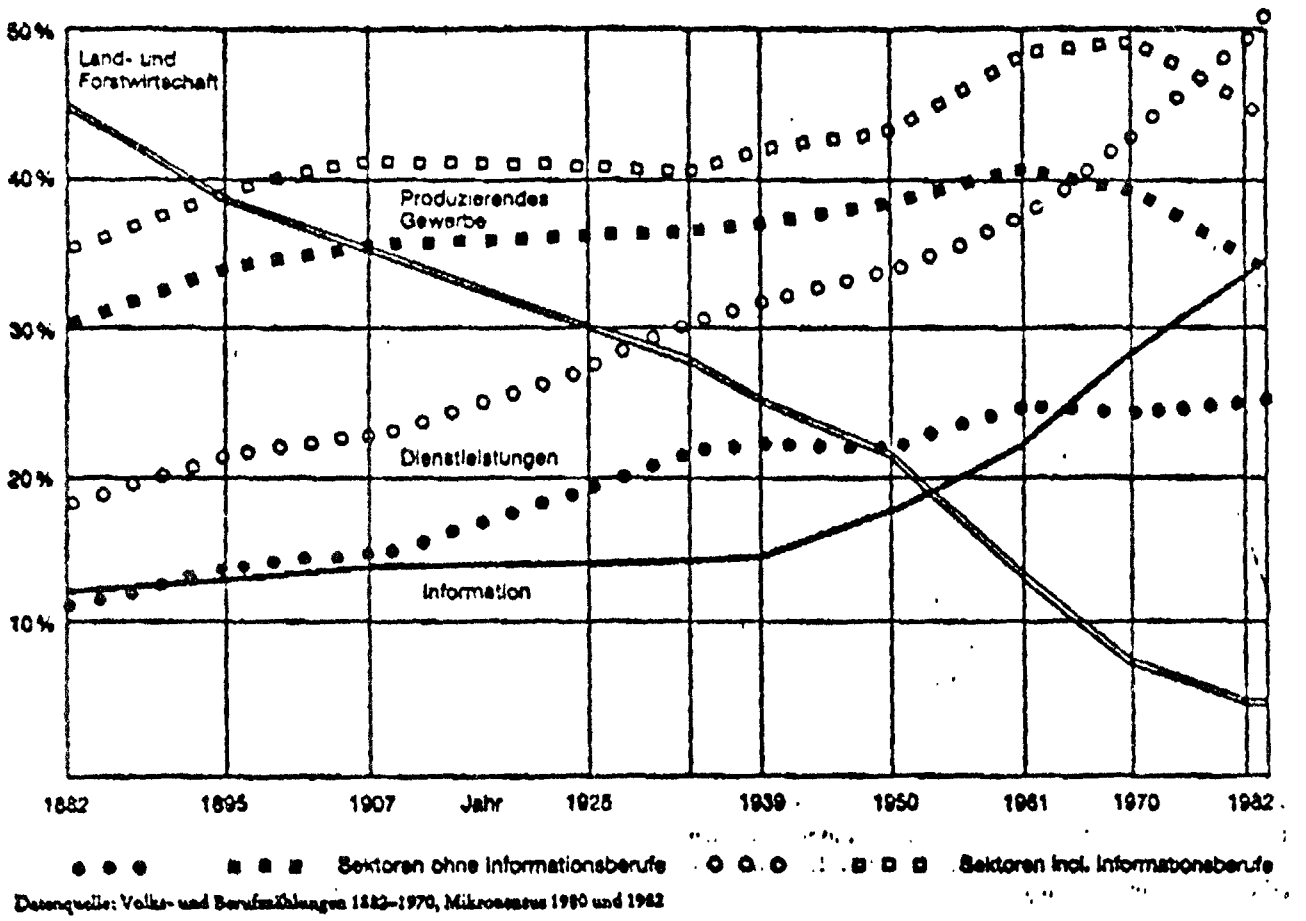
If economic output and input both decline equally there is contraction, if they increase expansion. Generally these terms only relate to quantitative shifts in products or production. The special feature of technological change, however, is that it causes changes other than simply an increase or decrease so that particularly in a stage of expansion technical changes are quite common. Expenditure for the next level of expansion is often not linear in the same way that contraction seldom causes linear economies. Expansion can therefore have an innovatory as well as rationalizing effect whereas contraction can easily lead to an increase in relative expenditure. Rationalization normally refers to all efforts to reduce the expenditure for a given result or to increase the output while maintaining a constant level of expenditure. The term innovation covers not only the object of technological change, invention, but also the entire developmental process.

The kind of innovation which must be encouraged to increase employment is that which has been seen to in the past to lead to more jobs. At the same time care must be taken that the rationalization effects created are not so great that they overcompensate for the increase in jobs. It is extremely difficult to guide technical change in this way as innovation and rationalization are very closely linked. There is the problem in industrial production of a dual conflict of interests: management's interest in low wage-costs contrasts with the workers' interest in high earnings, and the management interest in quantitative and qualitative availability of staff conflicts with the workers' interest in job security and self-determination. Particularly in periods of fierce competition, employers seek to solve this conflict with injections of innovation which can only be financed if resources are saved by rationalization. Rationalization then finances innovation. On the other hand rationalization can only take place if sufficient innovation is present. The scope for using technology policy as employment policy is therefore extremely limited. Economic developments such as expansion and contraction are far more effective because firstly they are not linked and secondly because they take effect more immediately than technical developments which require a considerable run up and tend as a result to proceed evenly. Expansion and contraction take place in the wake of shifts in the market. The technical implications of change are clearly a secondary issue. There is always the necessity to take account of non-technical elements and structures.

3.0 Effects on employment of technological and structural change

The development over the last 200 hundred years has also shown that the technical scope for overcoming natural limits for the length and intensity of labour has seldom led to reduction in human work but far more often to an increase in continually rising production. Greater consumption appears to have priority over reducing work.

Figure 3: Trends in employment in four sectors, 1882-1982



Datenquelle: Volks- und Berufszählungen 1882-1970, Mikrozensus 1980 und 1982

As figure 3 shows, the increase in the services, information and office sector is largely independent of the other sectoral development. If technological change had led to a loss of jobs, the number of office workers should have been sharply reduced by the introduction of microelectronics into the office sector. As the figure shows, however, the converse is true.

An analysis of structural reports(1) on trends in employment in West Germany in the period 1970 to 1982 shows certain interesting features. The determining feature for the serious quantitative and qualitative shift in employment was technical-organizational change in a majority of the areas of activity. The most striking loss of jobs, however, was precisely in those sectors where the influence of the structural change went beyond the influence of technical organizational adjustments so that technological change was not the determining factor but reinforced the trend.

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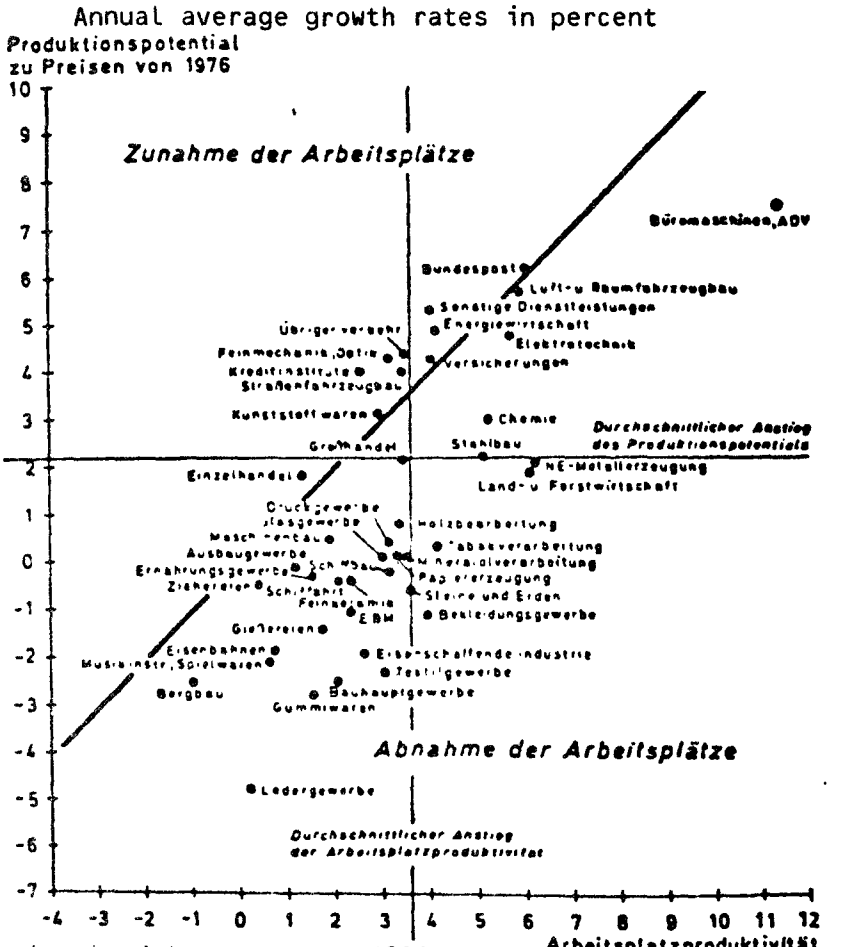
(1) Institut fur Weltwirtschaft und Beschaftigungsentwicklung in der Bundesrepublik Deutschland in den Jahren 1970-1982, Kiel, 1983, and Deutsches Institut fur Wirtschaftsforschung (DIW). Structural report, Berlin 1984

On average in the period under study the effects of the technical-organizational change to increase productivity has levelled off in all sectors. And productivity trends in the areas characterized by high input of new technologies have been little different than in the less technology-intensive sectors and almost always less pronounced than in the '60s. Only one third of technology-intensive firms have a rate of productivity above the overall average while in over half of these sectors the employment trend was more favourable than the overall average for the economy. The increase in jobs was particularly marked in the sectors where manpower productivity had risen by a disproportionately large amount, whereas jobs were mainly lost in those sectors with low productivity (see diagram 4). The failure to modernize has jeopardized more jobs than modernization. It is interesting to note which sectors cluster in the lower left-hand section of the diagram. This is the area where the increase in labour productivity was disproportionately low and the number of jobs declined. A slower gain in production therefore by no means insures against unemployment. There is no alternative to modernization.

PRODUCTION POTENTIAL
PRODUCTIVITY AND EMPLOYMENT 1973 TO 1982
Annual average growth rates in percent



Source: DIW-Strukturberichterstattung 1984, p. 153

It should also be observed that over 80% of the redundancies were in those sectors which faced relatively strong foreign competition on domestic and foreign markets. The loss of jobs was not brought about by an accelerated technical-organizational transformation combined with a noticeable rise in productivity but weak growth and strong international competition. Moreover, the growth in employment of almost 2% in the field of printing and reproduction in the growth period 1977 to 1980 contradicts the assertion that a particularly large number of jobs were lost in the printing sector in this period as a result of technical change. Nor is the drop in employment in the textiles and clothing industry particularly due to technological progress. If this trend were the result of technological change, then this sector of industry would have increased sales. But between 1973 and 1983 turnover only rose from 111.6% to 131.3%, i.e. did not even keep up with inflation. This decline in the textiles and clothing industry was in fact due to the following factors:

- Freedom of access to the Community market;

- Protective customs barriers and import restrictions in newly-industrialized countries because in such countries this sector of industry is as seen as the first stage of its industrialization;

- Low wage costs in newly-industrialized countries. Compared with European levels, wage costs are, for example, in Hong Kong only 19.6%, Taiwan 11.9%, South Korea 9.0%, in India and Thailand 6.4% and in Pakistan 3.5%;

- Loss of competitiveness among European textile companies which is not only caused by the pressure from third-country products with a low wage component but also increases in productivity in competing countries.

Similarly the areas of economy which receive particular attention in the context of technological change such as machine tools, electrical engineering, light engineering and optics tend to show average rates of change so that neither the general influence of technical progress nor in particular the development of microelectronics can be given as reasons for developments which would be contrary to the general trend.

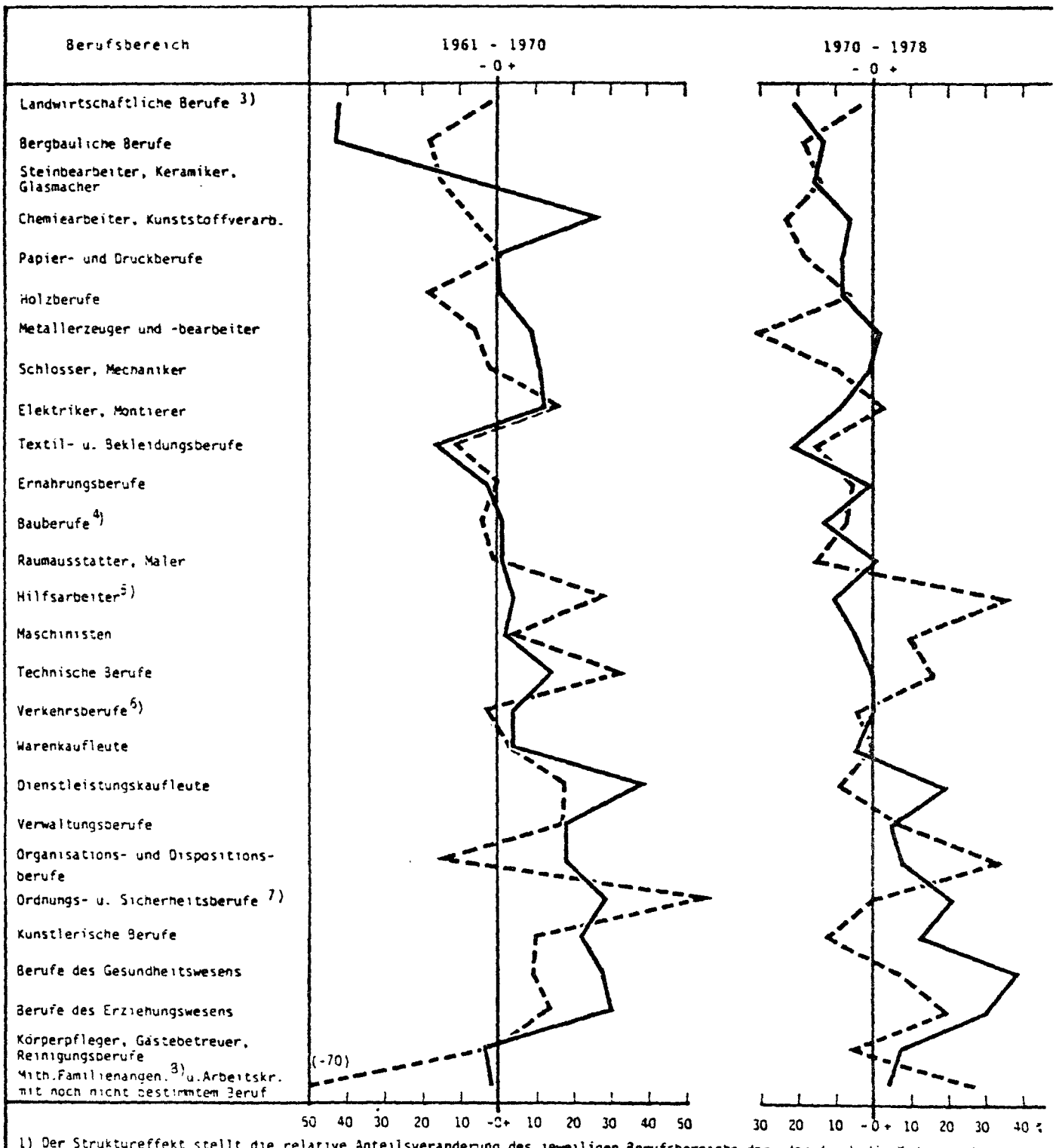
Technical-organizational change is not primarily the crucial factor determining the loss of employment and the causes for the persistent high levels of unemployment are, in addition to demographic components, the slow rate of technological renewal in industry which at the same time does not necessarily mean that individual forms of technology do not destroy jobs but only that the situation is far more complex.

The componential analysis of individual jobs into sectoral and technical-organizational aspects (see figure 5) shows the following major aspects of changes in employment:

Figure Components of the structural change in employment

Structural effect

Organizational effect



1) Der Struktureffekt stellt die relative Anteilsveranderung des jeweiligen Berufsbereichs dar, der durch die Anderung der sektoralen Beschaftigtenstruktur ausgelost wurde.
2) Der Organisationseffekt mißt den isolierten Einfluß der Berufsstrukturanderungen in den einzelnen Wirtschaftszweigen.
3) Einschl. mithelfender Familienangenoriger.
4) Ohne Bauhilfsarbeiter.
5) Einschl. Bauhilfsarbeiter.
6) Einschl. Versandfertigmacher und Warenprufer.
7) Einschl. Soldaten
8) Außerhalb der Landwirtschaft.

Quelle: Institut fur Arbeitsmarkt- und Berufsforschung; Statistisches Bundesamt; Berechnungen des ifo-Instituts.

IFO INSTITUT fur Wirtschaftsforschung München

Quelle: Abb. 30

The technical-organizational change has had positive effects on the following groups :

- organization and management,
- technical professions,
- machine operators and administration.

The negative effects have been on the following :

- metal producers and metal workers,
- chemicals and plastics workers,
- textiles and clothing,
- service salesmen,
- mining,
- quarrying, ceramics, paper and printing,
- building and allied trades.

The structural change has had positive effects on the following :

- services salesmen,
- health and education services,
- administration,
- organization and management,
- general and personal services.

The negative effects of the structural transformation were on :

- textiles and clothing,
- quarrymen and ceramics,
- building trades,
- chemicals and plastics workers,
- mining,
- paper and printing,
- building and wood trades,
- electricians and fitters,
- goods salesmen.

The basic trend is therefore that on the one hand considerable damage has been done to industrial professions from structural effects and that the technological transformation has reinforced this trend. In the technical professions, organization, management, teaching and health, the structural change combined with organizational changes and the use of new technologies have increased employment.

The effect on the labour market of new technologies is therefore often overestimated. The loss of jobs attributed to the new technologies may certainly be justified in individual cases at the micro-economic level but seen from the macro-economic point of view the effects are practically irrelevant. The trends in productivity in technologyintensive sectors was very similar to that in less technology-intensive sectors and above all far less pronounced than in the '60s. Since the '70s structural change has been proceeding less rapidly. The contradictions in the effect of technological change which were shown in the list of various studies are due to the fact that :

- most studies took no account of the time dimension,

- no adequate distinction was made between short and long-term effects so that the effects on employment were only analyzed at the point when technical innovations were introduced without any account of subsequent effects,

- account was only taken of direct effects so that the only evidence was of hypothetical redundancies and not of new employment because of improved sales potential,

- the studies took account of process innovation but not of product innovations which create employment,

- the effects of technological change were only studied from the micro-economic or macro-economic point of view.

No greater emphasis should therefore be placed on the influence of technological change on the labour market than the influence of other economic and non-economic factors which influence the process of structural change. The economic environment (demand and competitive position on the internal and world markets) has more influence on the introduction of technology than technology on the environment, for example microelectronics has not destroyed jobs it is the lack of competitiveness which causes firms to seek ways of reducing costs. In the medium-term the number of jobs in industry will decline. It is therefore not enough to create new jobs in this sector alone. New jobs must be created in the service sector in its widest sense. This will provide additional employment and help to protect jobs in industry because those who are employed in the service sector will have earnings which will generate demand for agricultural and industrial products.

The use of new technologies to develop new products generally leads to a rise in employment as a result of increased demand for new products. If on the other hand technology is used to change the production process, the effect on employment will depend on what extent the reduction in labour brought about by the new process can be compensated for by the increased demand resulting from lower costs or an improvement in quality or by employing workers on other activities such as planning, supervision and maintenance within the same plant.

The assessment of the indirect effects of technological progress is made more difficult by the fact that companies might lose their share of the market if they do not use the technology. Generally speaking there is a trend towards a decline in employment in manufacturing industry and an increase in the service sector. Technological progress takes account of the structural shift in employment away from direct manufacturing to upstream and downstream stages of production.

III. Interdependence of social, organizational and educational environment and technological development

From the practical point of view automation means the performance of routine, repetitive and monotonous tasks by machines. This covers those aspects of the production process which require physical strength or monotonous detailed functions from a complex procedure so that human labour becomes less an integrated component of the production process and more a supervising and controlling element. With a high degree of automation, manpower no longer becomes an inadequate substitute for a machine but consists in problem-solving and the management of specific tasks.

1. New technologies - Effects on job specifications

The following general trends can be observed : less emphasis is placed on specific skills and familiarity with materials and more on concentration, responsibility and the ability to react. Non-process specific, intellectual requirements come to the fore. In branches of industry with continuous manufacturing in which it is a question of ensuring the normal progress of physical/chemical processes, the new tasks of the worker consist in the supervision, maintenance and repair of machines. It is particularly important therefore for his training to have made him relatively flexible. On conveyor belts where productivity still depends on speed and the rhythm of work determines productivity, the change in specifications as a result of technical progress will depend on the function and nature of the work. In the processing industries, automation can make large numbers of semi-skilled and skilled workers redundant but at the same time the number of jobs in supervision, monitoring, control, programming and maintenance grows. The qualifications required may be higher or lower. In the service sector there is also a centralization of tasks which involves radical changes to job specifications. The more a sector is standardized the more trivial the manual activities become with a corresponding drop in professional qualifications and functions become concentrated in departments dealing with analysis, programming, marketing and administration.

The introduction of technological progress in the areas of manufacturing, office administration and other services means that the strict distinction between blue-collar and white-collar workers and between manual and intellectual work disappears. Both areas now have the possibility of offering workers higher qualifications and more intellectually demanding tasks. A major feature of automated manufacturing is the removal of all manual operations and procedures and the elimination of control and service functions in the immediate proximity of the machine. The task now is to ensure and supervise smooth running and the independent processing of information. The focus on process regulation disappears and is transferred to production planning and preparation of work, machine installation and maintenance, time and quality controls, i.e. areas upstream, downstream and parallel to production as such. The newquality features for human labour, new structures of activity and types of work and any higher qualification requirements are

therefore largely to be found in this area and not directly at the workbench with traditional skills. The introduction of data-processing microelectronics in particular has created new areas of work and new professions.

Technological change therefore is altering the qualifications required of workers. Microelectronics have made no difference to the job specifications of systems analysts, programmers or operators. Demand for such skills can only rise if such technology becomes more widely used and with the growing importance of software. Major changes are likely however in relation to mixed professions. In a large number of jobs, the workers will be confronted with aspects of microelectronics for which they have so far not been prepared. Additional qualifications will be needed and must be given to workers as part of retraining and to apprentices as part of their training courses. Peripheral professions need very little knowledge of the potential and constraints on microelectronics but such knowledge is increasingly becoming general knowledge as it is becoming more and more important outside the job sphere.

Some Member States are trying to convey the general knowledge needed by introducing data-processing as a school subject with support from the Commission's work programme on new information technologies and the school systems. It is however dubious whether the education system can act as the catalyst for technological change, as an institution which promotes or even accelerates innovation or whether in fact short-term economic interests have not been elevated to become a principle of educational policy. It is not a question of how to introduce the use of pocket calculators or classroom computers but a question of what syllabuses are important in a society in which information science is taking over more and more processes and access to information is easier and more simple. It would seem more important given the rapid change in qualifications required in employment to offer people a multidisciplinary education and to inculcate communicative and social behaviour so that on their own initiative they raise questions, find ideas, analyse problems, become integrated into a team and work within the team towards consensus. It is impossible to say at the moment whether the ability to reduce tasks to yes/no decisions will later prove helpful given the complexity of problems in working life. It would be better if qualified and motivated teachers made pupils appreciate information technologies and their uses and prepared them for the increased leisure which technological progress will bring.

Objective information to the public about the opportunities and hazards involved in technological progress is essential to counter the problems of acceptance in social groups. These arise because the introduction of new technologies often have polarization effects and lead to a disqualification of workers and technological progress to redundancies. To prevent the pressure on workers from technological progress, skills must be acquired in basic education which can be widely applied. Given the scale of intensity of the social transofrmation brought about by technological change there needs to be close cooperation and a dialogue in the education sector between politicians and social partners, to develop strategies which can be sufficiently flexible even in the light of unforseeable developments. They must include :

- a comprehensive flexible education,

- specific qualifications to ensure the necessary flexibility when specifications change,

- adjustment of training demand to technological progress in the form of special training and retraining programmes,

- the possibility for workers to exercise an active function by virtue of their training for the introduction of new technologies,

- legal or contractual guarantees of further training and retraining aid to those affected by technological change.

Reaction to technical change is very dependent on previous experience and the willingness of those concerned to learn. But to a considerable degree the capacity of a national economy to adjust to changes in structures, and ultimately its competitiveness will depend on the mobility of the manpower factor in geographical, sectoral and also professional terms.

The problems for those affected by technological change do not only result from changes in the qualitative and quantative job requirements, restructuring of the work place, the learning of new activities and abandoning familiar places of work and working situations. A further group of problems can be caused by changes in social communication. These are largely characterized by inter-personal relations within companies, the organizational structures and procedures found there and outside companies at association level and in politics.

Problems of social organization and communication can arise because:

- realignments at the expense of hitherto leading groups can create anxiety which considerably reduces the willingness to adjust and participate,

- other groups of workers who are dynamic and willing to innovate violate the existing codes of conduct and claim greater influence and

- personal continuity in representative bodies changes as a result of the growing influence of hitherto less committed staff (for example white-collar workers in industry).

2. The role of the social partners in technological change

The extent to which technical changes lead to social problems and social conflict depends very much on the external situation which these changes encounter and the way in which people react to conflicts of interest and problems.

In all areas in which there is open communication on problems and full participation on the basis of equality to seek cooperative solutions to problems, the conflicts which arise from technological change are relatively minor.

But where there is not sufficient information at the right time, where information is held back and where polarization and confrontation strategies prevail, social problems caused by technology can easily exacerbate the situation.

Cooperative communication between management and workers' representatives both within companies and plants and at a higher level can avoid social conflict and problems of acceptance and the sources of innovation can be permanently stimulated and encouraged both from the micro-economic and macro-economic points of view. Otherwise there is bound to be growing hostility towards industry and technology which will take its toll of businesses, economies and societies. Thus a structured balance of interests is essential for the productive organization of the reciprocal effects of technology and the social sphere. Technological change can only be introduced for the benefit of all if there is consensus between the social partners. A good example for a mutually beneficial process of communication at this level is the dialogue between trade unions and companies in the German watch and clock industry, the dialogue on microelectronics, the debate on improving working life and the environment. These exchanges between the social partners must be intensified and institutionalized. They must not be threatened by a tendency towards polarization and animosity as a result of the persistent high levels of unemployment and radical restructuring in business which places a considerable burden on the existing system of social partnership. There should therefore be some kind of European law on the constitution of enterprises covering information, consultation and the necessary negotiations between employers and workers on proposals for rationalization, working methods, manufacturing processes, health protection and safety at work.

3. New technologies - effects on health and safety

Dangers to health, particularly the psychological stress and strains which arise as a result of the changes due to technology can be reduced by social consensus. It is less a question of physical strain which is largely removed by technological progress, but of the strain created by the requirement to adopt, adapt and use or produce information, the so-called information and mental activities. The nature and extent of the psychological strain will depend on personal circumstances such as psychological state, state of health, individual capacity to cope, motives and experience. It is important that there is a general match between the requirements of the job and personal qualities. If the requirements of the job and the personal qualities do not match the person will either be unable to cope or less than occupied. Both these states may be expressed in quantitative terms (volume of work compared with working time) or qualitatively (type of work, level of difficulty).

Normally people with timed, monotonous, repetitive boring activities usually feel they have less than enough to do whereas quantitative non-coping is usually characterized by the volume of tasks per unit of time.

Over-qualification results when existing working skills cannot be used and further developed. If on the other hand the skills available are not adequate for the difficulty or complexity of the task, this results in qualitatve non-coping behaviour which may also result from the ambiguity or incompatibility of tasks.

In quantitative non-coping situations physiological stress may result in a faster pulse, increased production of stress hormones or increased chlorestorol levels.

In qualitative non-coping situations psychological problems such as discontent, tension or inferiority complexes may result. There is a proved causal link between heart/circulatory disorders and such situations.

Where people are not fully occupied however, there is a reduction in circulatory activity, an increased fluctuation in performance accompanied by general fall in performance and increased risk of error, slowing down of motory responses and experience of the situation as monotonous, boring and stupefying. Once the decline in physical and mental activity is incompatible with the work performed, the worker must make additional efforts to achieve the performance required.

Specific professional knowledge, skills and abilities and general qualifications enable the pressures of work to be more easily overcome. Well qualified workers also are more likely to have skills and strategies to meet the higher requirements. Aspects of work organization (such as changes, expansion and enhancement of work) can increase the individual's room for manoeuvre and avoid psychological strain. Thus problems can appear less important if they are more predictable, comprehensible and as a result manageable by extending the individual's scope for control.

If the social pressures caused by technological change can be avoided, the potential of technology to benefit mankind can be used to create a broader scope for organizing working conditions. The technical feasibility of cooperating across long distances and the fact that it is no longer necessary for all workers to be present at the same time frees production from rigid working time arrangements, regulations and business hours and offers options as regards the scale of work and output, timetabling, local working conditions and other aspects of the work process.

In its work programme on 'vocational training and new technology' for 1985 the Commission rightly points out that its programme as presented can only form part of an overall strategy to ensure that human resources are adequately prepared for technological change and industrial renewal. For this reason action programmes are being prepared to improve the transition of young people from school to adult and working life, to strengthen cooperation between business and universities in the development of new technologies and to help integrate women workers to a greater extent in the technology process. The Commission is also right that at Community level there should be more comparative analysis of the effects of new

technologies on employment, qualifications, pedagogical training and syllabuses than independent analyses. But it should also take account of the precarious budget situation. Extensive studies have been carried out in the Member States on the effect of modern technologies on the labour market. What is needed is a compilation and comparative analysis and assessment of the research work which has been carried out or is in the process of being carried out in the Member States. An assessment of the experience gained with programmes initiated in the Member States which was made available to all those interested would help to alleviate the negative effects of technology transfer on working life. This is what the scarce financial resources of the Community's budget should be used for rather than initiating wide-ranging programmes which, because of the lack of financing, would be no more than a drop in the ocean and give the impression of too little too late.

IV. Opportunities and hazards of genetic engineering

Technological break-throughs (the steam engine, the internal combustion engine, nuclear energy, information science) always involve impulses which transform technical and social life. Biotechnology, stimulated by genetic engineering, may once again lead to radical changes in production, society and the environment. Because of ignorance some people fear genuine and supposed risks make it impossible to master such technology.

1. What is genetic engineering and what can it do?

Genetic engineering is concerned with the analysis and reconstruction of genetic material using biochemical and molecular biological methods; this does not include in vitro fertilization (test-tube babies), sperm donors and surrogate mothers. It enables the genetic construction and function of inherited tendencies to be analysed; for example the form genetic information takes, how it is transmitted and how these processes are regulated in time and quantity or how the growth of cells can be controlled, why errors sometimes occur and lead to the formation of cancer. Genetic methods also allow however the more or less deliberate transmission of genes from one organism to another; for example the insulin gene from a human can be inserted into the bacteria escherichia coli and stimulated to synthesise insulin or the creation of an new antibiotic by combining the genetic information of various antibiotics. Using genetic engineering man is able to organize biological structures, protein molecules or cells for his own purposes. Thus specific vaccines used in medicine (for example against hepatitis, insulin, Interferon) could be produced more cheaply, inherited diseases recognized and cured, genetically determined acceptability of medicaments established and the causes of disease (AIDS) proved more rapidly, new plants developed in agriculture and their resistance to disease improved.

2. The hazards of genetic engineering

The risk that the adulteration of the genetic information in various organisms could lead to such combinations producing new, unknown sources of disease in the environment or the development of micro-organisms for biological warfare has led many countries to introduce legislation on systems of restrictive physical and biological safety measures but these have constantly had to be adapted to the state of scientific knowledge.

The dangers which could arise from genomic analysis and gene therapy on human beings are far greater and need to be assessed from the ethical point of view. Gene therapy attempts to repair genetic defects by inserting genetic material into cells. Genomic analysis investigates whether an individual is the bearer of a genomic disease, possesses the genetic disposition for incompatibility with a given medicament or on the basis of his genetic disposition is more likely to fall ill at a certain type of workplace than people with other genetic patterns.

In principle manipulating nature is ethically permissible. But it must take part within a wider responsibility for assessing the potential effects on nature and mankind. The freedom of research is not absolute : its limits are dictated by the well-being of mankind. As long as there is no psychomatic change to people, genetic methods raise no ethical problems. Not every manipulation of genetic material in human beings is unjustified; for example the replacement of a defective gene in the appropriate cells for the the formation of blood by an intact gene is comparable with an organ transplant. The main point is that genetic engineering should be geared to therapy and aspire to an additional gain for humanity. Moreover it should only be carried out on a voluntary basis and for the well-being of the individual, and not for any possible discrimination (for example in work) as this would represent a violation of the basic rights of the individual, and in particular violation of the principle of equality.

Eugenics, i.e. the genetic implantation of a gene in a fertilized egg, is however an extremely dangerous development. It opens the way for breeding human beings. Genetic technology must not lead to domination of people by people. The breeding and cloning of optimized human beings therefore should be excluded on the principle of human dignity. The autonomy of the person and freedom of the individual to seek his identity has its biological root in the fact that the genetic endowment of each individual is not identical.