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West Europe Report

SCIENCE AND TECHNOLOGY

(FOUO 2/80)

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WEST EUROPE REPORT

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FEDERAL REPUBLIC OF GERMANY

GOVERNMENT SUPPORT FOR R&D IN SMALL, MEDIUM-SIZED FIRMS

Financial Support

Munich RATIONALISIERUNG in German No 11/79 pp 272-274,283

/Article by Hans-Dieter Steguweit: "Subsidies to the Costs for Research Personnel"/

[Text] Small and medium-sized enterprises of the producing sectors, whose registered place of business is in the Federal Republic of Germany, can now be granted contributions to the expenditures on personnel engaged in research and development (R&D). Applications for subsidies appropriated in the 1979 Federal Budget and computed on the basis of the preceding year (1978) must be received by 30 September (final date!). The following account presents the most important details.[1]

The subsidies are intended to boost the efficiency and competitiveness of small and medium-sized enterprises of the producing sectors by enabling them to consolidate and increase the number of personnel engaged in research and development and thus to create the preconditions for production and process innovations. The producing sectors include: The manufacturing industry, the building trade, the energy and water supply sector, and the mining industry.

In the small and medium-sized enterprises of German industry, salaries and wages account for approximately two-thirds of the research and development costs. At least every fourth of the enterprises in the manufacturing industry employing fewer than 1,000 workers--i.e. approximately 10,000 small and medium-sized enterprises--is engaged in research and development. The new measure is to close a gap in the system of technological support measures in industry--a gap that remained after last year's introduction of a 30-percent contribution to contractual research and after the sizeable increase in the contribution to research and development investments. Table 1 presents a synopsis of all measures in support of research and technology in small and medium-sized enterprises.

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1. Even though the deadline (end of September) for applications for cost contributions for 1978 passed, the following account is published here, since it provides an overview of the pertinent problems of 1979.

Enterprises Entitled to Support

According to the "R&D Personnel" Guideline, an enterprise of the producing sectors is entitled to apply for support, if it meets the following three preconditions:

--During the last 3 years, its average turnover must not have exceeded DM 150 million, or it must have employed fewer than 1,000 workers. It is sufficient, if one of these conditions is met.

--No enterprise(s) with a turnover exceeding DM 150 million may have a controlling interest--directly or indirectly--in the firm concerned, nor may a holding company have a controlling interest, if the holding company on its part has a controlling interest in an enterprise with an annual turnover exceeding DM 150 million.

--For the preceding year, the enterprise must furnish proof of research and development work aimed at developing technologically new or improved products or processes with the object of improving the economic efficiency of the applicant enterprise.

Although the subsidy is computed on the basis of the expenditures of the preceding calendar year, it is not a subsequent compensation for the preceding year, but a contribution to the expenditures of the current year.

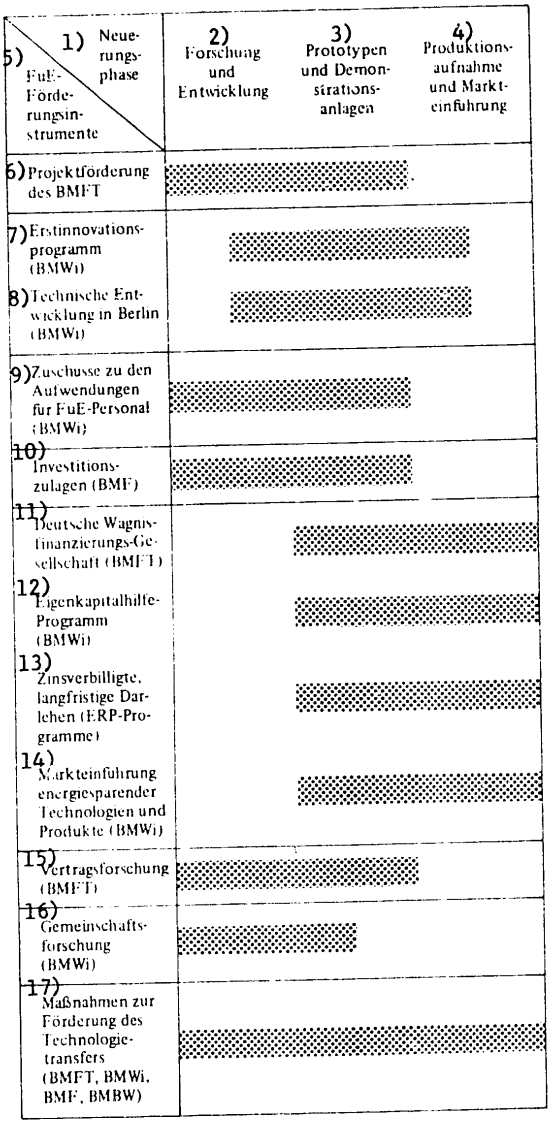
Amount of the Contribution

The maximum subsidy paid per year and enterprise is DM 400,000. In order to provide a relatively stronger incentive for enterprises with an as yet underdeveloped research and development program--i.e. for the smaller enterprises in particular--the first DM 300,000 of salaries and wages for R&D personnel are subsidized through a 40-percent contribution, whereas for the further expenditures (up to a total cost of DM 1,420,000) the subsidy amounts to a mere 25 percent. As regards the respective expenditures of enterprises in Berlin, the higher allowance rate of 40 percent is applied throughout. For these enterprises, the maximum subsidy granted per year and enterprise amounts to DM 500,000. To obtain this maximum amount, the Berlin enterprises must furnish proof of having paid out taxable gross R&D wages and salaries totaling DM 1,250,000.

Calculation of the Contribution

As for the calculation of the contribution, only the taxable gross wages and salaries--not the total labor costs--are taken into consideration; incidental personnel expenditures are not included. The Federal Government estimates that on average the taxable gross salaries and wages account for approximately 80 percent of the labor costs.

Table 1. Measures in Support of Research, Development and Innovation



Key:
1. Innovation phase
2. Research and development
3. Prototypes and demonstration installations
4. Start of production, marketing
5. R&D support measures
6. Project support by the Federal Ministry for Research and Technology
7. Original innovation program (Federal Ministry of Economics)
8. Technical development in Berlin (Federal Ministry of Economics)
9. Contributions to expenditures on R&D personnel (Federal Ministry of Economics)
10. Investment subsidies (Federal Ministry of Finance)
11. German Venture-Financing Co. (Federal Ministry for Research and Technology)
12. Capital resources support program (Federal Ministry of Economics)
13. Long-term low-interest loans (European Recovery Programs)
14. Marketing of energy-saving technologies and products (Ministry of Economics)
15. Contractual research (Federal Ministry for Research and Technology)
16. Joint research (Federal Ministry of Economics)
17. Measures in support of technology transfer (Ministry for Research and Technology, Ministry of Economics, Ministry of Finance, Ministry of Construction)

A contribution can be granted only to that share of the taxable gross salaries and wages, which is paid--at an appropriate level of compensation--for actual research and development work (in research and development departments, design offices, laboratories, testing shops, or at work places specifically set up for such projects). Not to be taken into consideration are the wages or salary of an employee who in the course of 1 year was directly engaged in research and development for fewer than 400 hours.

To the extent that the employees are engaged in development work for other enterprises or in development that is part of production projects of other enterprises, the costs incurred may not be subsidized, for such projects lack the typical entrepreneurial risk of research and development. In order to prevent duplication of support, contributions cannot be granted to those labor costs that are already being subsidized by agencies of the state or of the European Community.

Appropriation Procedure

The Federal Ministry of Economics has entrusted the Arbeitsgemeinschaft Industrieller Forschungsvereinigungen e.V. [Working Group of Industrial Research Associations, Registered Association] (AIF) with the implementation of the support measures. Upon request, the AIF (5000 Cologne 51, Bayenthalguertel 23) gives out the guideline, an informative booklet and the application forms. The application must be submitted by 30 September. Since the Federal Government in designing the forms restricted itself to the essentials, it is hoped that in contrast to the Original Innovation Program the individual businessman will be able to handle the application procedure without difficulty and without any need for special advice. The AIF claims to have taken the steps necessary to ensure rapid processing. According to the AIF, for the measure to be effective it is essential that the subsidy be paid out within a few weeks.

According to the budget of the Federal Ministry of Economics, DM 300 million are available for the current year and the guidelines stipulate that the subsidies be taken from this fund. Since the Federal Government holds that due to the lack of informative statistics no predictions can be made as to the number of applicants and the volume of applications, it was decided that for the time being no enterprise would have a legal claim to any subsidies. The Federal Government pointed out, however, that there would be no annual "greyhound race," since for the measure to be effective it was essential that in its research and development planning each of the qualified enterprises be assured of receiving support. Nevertheless, it is advisable to apply at an early date, since according to an Ifo [Institute for Economic Research] study the personnel expenses admitting of being subsidized are likely to exceed DM 3 billion in 1979.

Table 2. Borderline Cases and Their Classification

Operation	Part of R&D	Not Part of R&D
Systematic definition of the desired characteristics of a product/process	Formulation of the idea at hand; determination of the potential demand for the technical idea defined; planning of r&d work	Search for ideas; routine, general market observation
Search for solutions	Patent and literature research; search for suitable materials and equipment; analysis and evaluation of alternatives	Routine utilization and processing of scientific and technological information, inclusive of observation of certain patent classes, unless this observation is carried out exclusively for certain r&d projects
Planning and development of the solution intended	Designing of prototypes or test installations and of the special tools necessary for their production and testing	Designing and manufacture of the tools necessary for production; design of the end product; advance production planning (operations scheduling)
Prototypes or test installations for a production process	Production, testing with all modifications required until all essential operational features of the planned product/process are developed	Test quantity production; routine inspections and quality controls
Adaptation	Development work in connection with the transfer of technologies to another production scale; in connection with the transfer of new technologies concerning the adaptation of existing products to another/new field of application or concerning the adaptation of production processes	Work concerning the smooth organization of production or control; organizational changes are not part of r&d, even if they are necessitated by the introduction of new technological systems

Table 2 (cont.)

Operation	Part of R&D	Not Part of R&D
Additional development work subsequent to start of production	Work in connection with technical improvements of the product or process with the object of attaining the r&d objective defined	Work concerning the smooth organization of production or control; quality controls; elimination of production snags
Patent and license work	Work in connection with the obtainment of industrial rights (patents, registered designs) for the solution found, including patent application	Work concerning the protection of patent rights and the sale or licensing of the know-how acquired

Statement of Expenses

The documentation required in support of the application includes the application form and a statement of the research and development personnel expenses admitting of subsidization. In the enterprises, every employee who is not exclusively engaged in research and development and whose work is to be subsidized must keep a record of the hours spent on research and development. At the end of the year, the respective hours of the various employees are to be entered along with the respective wage or salary amounts in a comprehensive voucher.

This voucher must be certified by a certified public accountant or tax advisor. The certification does not extend to the necessity of the research and development work or to the material substance of the work performed. The C.P.A. or tax advisor merely confirms--on the basis of the company's records and books--the accuracy of the objective data.

As regards the statement of personnel expenses for 1978 and 1979, there apply less stringent, provisional regulations: A "conscientious estimate, combined with a detailed, but brief description of the research and development work of each employee" is sufficient.

Work Admitting of Subsidization

Since in the individual case the delimitation of operations admitting of subsidization can be quite difficult, the Federal Government supplemented the "R&D Personnel" Guideline with a commentary; a catalog (Table 2) indicates which of the individual operations are part of research and development and which are not. The Government proceeds from the assumption that

any work can be considered to be part of research and development, if it aims to

--gain new scientific or technical knowledge and general experience;

--develop new products or production processes;

--further develop products or production processes, insofar as significant modifications of these products or processes are desired.

Development is defined as systematic evaluation and application of research results and experience of a primarily technical-economic nature with the object of obtaining new systems, processes, materials, products and equipment (new development) or of improving existing ones (further development). Testing (prototypes: Pilot-, demonstration- or reference installations) intended to determine the characteristics as defined by the development objective is part of development.

Taxation

Like other forms of state financial support, the contributions to r&d personnel expenses are taxable. Thus the liquidity boost intended through the subsidies is diminished considerably. Upon deduction of the current profits taxes (corporation profits tax or income tax and church tax, and in addition a 15- to 20-percent tax on trade returns) and of the nondeductible property tax burden for several years, what remains of the subsidy amounts to no more than 25 percent. Consequently, in terms of taxation, bank credits can be more advantageous, since they are treated as repayable loans. To be sure, such loans bear interest and as a permanent debt they may be subject to trade tax. However, the tax prepayments for the contributions to r&d personnel expenses must likewise be financed, and from a calculation point of view, interest must be assessed.

The situation is different, if a bank credit is denied on account of the enterprise's insufficient productive capacity or the lack of securities. Under these circumstances, r&d subsidies are the only alternative. Support will be denied only if at the time of application the enterprise has become insolvent or if bankruptcy, settlement or execution proceedings have been instituted.

All in all, the new support program enables numerous small and medium-sized enterprises to meet the rapidly increasing personnel expenses in the field of research and development. Among the obvious benefits are the unbureaucratic processing of the support applications--which is handled by a self-help organization of industry--and the absence of any form of investment control: Through its contribution to personnel expenses, the state rewards the performance of the enterprises irrespective of whether the respective processes or results are considered promising or economically valuable.

Dissemination of Information

Munich RATIONALISIERUNG in German No 12/79, pp 312,313

[Text] The Working Group for Innovation, Technology Transfer and the National Economy continues to concentrate its activity on the pilot project entitled /technology transfer for small and medium-sized enterprises/ [words in italics]. For the purpose of supplementing and supporting this project, the Federal Ministry of Economics in 1978 established the project entitled /promotion of the innovation efforts of small and medium-sized industrial enterprises through systematic innovation counseling/ [passage in italics].

The project focuses on the needs of the enterprises counseled. In contrast to the so-called "technology push" that has for some time been practiced by some information producers, the emphasis in RKW [Efficiency Board of German Industry] project work is decidedly on "demand pull." So far, this demand-oriented attitude has proved successful.

The project includes the following key elements: Analysis of problems in the enterprises; determination of the need for external know-how; demonstration of potential solutions; establishment of contacts; advisory support of the enterprises' cooperation with problem solvers and suppliers of know-how. The experience gained so far has shown that first and foremost there is a transfer of know-how, whereas the transfer of complete technologies remains the exception. For this reason, technological counseling should almost always be part of a more comprehensive innovation counseling.

On the basis of this realization, there developed the /demand-oriented, integrated technological and innovation counseling/ [passage in italics] which comprises technological, economic and social aspects in the introduction of new technologies in small and medium-sized enterprises.

The results obtained testify to the necessity and the acceptance of the innovation measures in the enterprises. The RKW concept of demand-oriented integrated technological and innovation counseling as a support measure aimed at promoting self-help has been accepted. The experience gained in the project is based on contacts with approximately 500 enterprises and on over 50 consultations with external specialists. The areas of main emphasis are the following:

--Examination of the enterprises and determination of the need for know-how including the search for and referral to external specialists and the development of enterprise-specific innovation strategies;

--advice on state support measures, referral to appropriate support agencies, and assessment of the acceptance of the state measures;

--suggestions to the know-how institutions in regard to demand-oriented, focal R&D areas.

During the consultations with outside experts, there emerged two areas of special emphasis:

a) Intensive technological counseling;

b) counseling on market research.

An overly narrow restriction to technological problems did not prove expedient in practical work. /For innovation counseling to be effective it is essential that an attitude conducive to innovation be established in the enterprise/ [passage in italics].

The innovation consultants help reduce the operational risk which in the field of technological innovation is considerable.

The future areas of main emphasis in technological and innovation counseling will be the following:

--Intensification and complementation of the counseling work;

--following up on the results produced through counseling;

--passing on to the support organizations recommendations concerning the further development of the innovation support programs;

--development of proposals for some kind of innovation counseling as an RKW service.

In the introduction of new technologies and in the development of product and process innovations, the technological and innovational consultants take into account the social consequences. In individual cases, positive effects can be demonstrated. However, on account of the fact that the project has been operating only for a short time it is not yet possible to make a definitive evaluation.

Nevertheless, a number of conclusions can be drawn at this point:

Individualized technical-economic counseling is feasible, as are transfers of technology. It is unlikely that this individualized information can be offered to the recipient enterprises as a freely financed service. A cost-recovering imposition of fees will probably always be feasible only after the attainment of the phase during which the concrete (technical, technical-economic or economic) counseling is arranged by a third party.

Complementary Measures

As is evidenced by over 1,000 referrals in the course of 1 year, the "Innovations-Licenses-Patents" Information Service has proved a success. The service has lately been used by foreign suppliers and customers as well.

The Federal Ministry of Economics also established a public relations project. Within the framework of this project, the "Technology Transfer" project of the Federal Ministry for Research and Technology was exhibited at the Hannover Fair, at the SYSTEMS 79 Exhibition and at the Stuttgart INNOTEK Exhibition. The visitors' great need for information testified to the appropriateness of these measures.

Another concern of the Working Group is the transmission of general economic information to small and medium-sized enterprises. A key element in this activity is the WIRTSCHAFT AKTUELL information service which is published bimonthly and which reports on economic changes in industry and in the labor market, on finance and investment problems and on foreign markets.

Another element supporting this work is the Study Group for Overall Economic Developments which was established approximately 3 years ago and from which emerged WIRTSCHAFT AKTUELL. The Study Group is made up of experts from the following fields: Banking, economic research institutes, industry, ministries, Federal agencies (e.g. Federal Office for Statistics, Federal Office for Foreign Trade Information).

At its meetings, which for the most part are held twice a year, the Study Group deals above all with problems that are of interest to privately owned industry. The following subjects have been discussed over the years:

--Labor market trends;

--intermediate technologies;

--energy policy trends;

--structural changes.

On the basis of the makeup of its membership and the resulting professional expertise, the Study Group has taken on another project--"Structural Changes in the German Economy."

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FEDERAL REPUBLIC OF GERMANY

OVERVIEW OF PROSPECTS, POLICIES FOR R&D, INDUSTRIAL GROWTH

Munich RATIONALISIERUNG in German No 11, 1979 pp 267-272

[Revised version of a lecture by Ministerial Director Dr Friedrich Bischoff, Bonn, delivered in Mannheim on 2 February 1979 at the invitation of the Dresdner Bank AG]

[Text] From the aspect of the national economy we are particularly interested in the potential for innovation available in private enterprise, which will secure future growth and employment. Are there any barriers or obstacles obstructing the full development of this innovative potential of our economy? Could and should the government lend a helping hand--and if so where and how (by the use of which tools)?

Successful innovation is largely a matter of management. And here let us not forget for even a single moment that management has become increasingly difficult in the recent past. The growing dynamism of markets and world trade interrelations, shorter product life cycles coupled with longer lead times, the unpredictability of the trends of exchange rates, OPEC price jumps, the inflation of raw material prices--all these make business calculations extremely difficult.

Every businessman acknowledges as one of his central principles that new products acquire a value only upon sale. However bold an entrepreneur may be, he must also, and especially, be a man bent on safety. This sounds like a paradox but is comprehensible once we consider the challenges by which he is confronted from the ranks of employees, stockholders and lending institutions, his suppliers and the government. All of them rely on the company, expect it to yield income, return and taxes. As a result there is the danger that risky ventures into new markets, the commitment to new technologies, the early transfer of research and development may become a gamble and that necessary innovations be impeded.

And yet economic growth means first and foremost that future economic scarcities should be overcome by innovations. Economic development proceeds in the field of tension between "needs" and "scarce resources," primarily natural resources: Raw materials and energy as well as manpower and its skills.

Changes in the ratio of scarcity shift need structures and reveal bottlenecks calling for innovations. Such bottlenecks are the propellant of innovation. They must be consistently and systematically sought.

Resources such as clean air and water, for example, were taken granted for many years because everyone believed that their supply was limitless. At this time it is evident that they must already be counted among the scarce resources. Needs have changed as a consequence of the excessive drain on water, the air, in fact our entire environment, by waste gases, wastes and pollutants. The visible expression of this change is the emphasis on the improvement of the quality of life. Industries making available new waste water technologies, developing concepts and processes to reduce and remove wastes, offering low-emission process technologies--these are now among the industries enjoying the prospect of above average growth rates.

World Economic Developments...

If we consider future bottlenecks the prime motive force for new approaches, in fact concepts for economic evolution as such, we will need consistently to orient business decisions to future demand structures and markets.

Economists are generally agreed that a forecast of the development of overall economic conditions must precede any attempt at estimating future needs and demand structures. In view of the large role of exports in the German economy it is imperative especially to watch for changes in the world economic division of labor. Actually there is already a broad consensus regarding the most vital trends:

-- 1. So-called industrial threshold countries are increasingly in evidence on the world market offering technologically simple industrial goods. As a consequence conditions for mature and high-intensive manufacture at home will be more difficult.

-- 2. The raw material countries, in particular oil producers, are eager to process their raw materials at home. Energy and monetary capital is in abundance there. This threatens the competitiveness of important energy intensive or raw material processing industries--for example sections of the chemical industry.

-- 3. Additional problems arise from the radical shifts in exchange rate ratios, which rather abruptly reduced the international competitiveness of wage cost sensitive product categories with mature technologies by comparison to low wage countries, but also of technology intensive product categories vis-a-vis other industrial countries. Glaring consequences of this trend may be observed in the steel and shipbuilding industries.

Even at home we are confronted with some difficulties and the need to make structural adjustments:

1. The need to catch up with regard to goods and services, a phenomenon of postwar reconstruction, has yielded to noticeable satiety especially in the sector of durable consumer goods. What demand there now is favors goods of excellent technical and design quality, usefulness and durability.

2. New needs--better education, more comfortable housing, a clean environment, recreation and leisure facilities--have come to the fore. This amounts to a shift to new fields of the demand for goods and services.

3. It is part of this shift in values (evident, for example, in the emergence of many citizen initiatives) that industrial goods production and economic growth may no longer proceed at the expense of the environment, public health or at the hazard of future generations.

-- What are the consequences arising from these domestic and general economic shifts for the technological development of the German economy?

-- What are the key issues for research and development?

-- Where especially should the government assist and strengthen the research and development efforts of business?

-- Entrepreneurial Expectations...

We will be able to maintain our present strength on foreign markets only if we put even greater emphasis on advanced production techniques which require a great deal of skill from the labor force. It is a plus for us that the demand for such goods is bound to rise substantially.-- The speed-up of growth in formerly less developed countries raises the demand for the kind of goods which we are well situated to supply. This holds true not only for industrial plant but also for technology-intensive consumer goods.-- However, we will only be able to reap the fruits of this development if we can maintain our present market share with regard to these goods. We are subject to serious competition from other highly industrialized economies. In the long run our competitiveness will depend on whether we succeed in turning out a sufficient volume of new and high quality products and processes in the traditional sector of export goods.

Our economy is thus confronted with the task of securing for the future also its strong competitive status with respect to traditional investment goods, especially by the integration of modern data processing technologies. Components of this technology, ranging from very specific sensors to microprocessors, are gaining increasing importance for wide sectors of the machine construction industry. If we wish to main our large share of the export market for manufacturing plant, manufacturing technology complete with integrated data processing must be a key concern in our research and development efforts.

Already the United States and Japan are ahead of us. In view of the growing importance of this sector a group of experts was called in by the Federal Ministry for Research and Technology to find out whether it might be necessary to set up a special promotional program "manufacturing technology," designed to help the manufacturing industry, machine and plant construction and equipment industry integrate the techniques of microelectronics, sensor technology and data processing in future-oriented products and processing concepts able to hold their own on the world market.[1]

The immense future importance of this sector for our economy is demonstrated by the results of a study carried out by the German Institute for Economic Research on behalf of the machine industry research board. The institute studied the effects of foreign demand for large-scale plant on output and employment in the Federal Republic of Germany. The study was based on five completed projects of large-scale unit construction (ethylene plant, cement factory, desalination plant, pelleting plant, continuous casting plant). The relevant results were as follows:

-- The additional demand for large-scale plants with a contract value of about DM500 million induced production effects to a total value of DM1.7 billion in the industries involved.

-- Related to manpower, the employment of a total of 15,000 people, the equivalent of 15,000 man years, was calculated.

-- Related to the total receipt of orders by large-scale plant construction firms in 1977, amounting to DM9.4 billion, the gross production induced thereby was estimated at about DM32 billion and the effect on employment at nearly 276,000 man years.

These results convey a good idea of the impact of large-scale plant construction and its products on output and employment.

As a leading industrial nation we must also turn our attention to the problem of the poorer developing countries--not only for humanitarian reasons and with an eye on long-term peace but also by reason of the economic-ecological consequences of poverty and overpopulation.

... As Economic References

Especially important tasks for the industrial countries include ecologically sound agricultural development, effective pest control, the adjustment of traditional and modern technologies to the particular needs of the developing countries as well as aid in the establishment of a viable infrastructure. The use of modern solar and biotechnologies, for example, offers considerable innovation potentials for the German economy.

Even on the domestic market (despite a certain satiety of demand) we note several demand and bottleneck factors offering opportunities for innovation, for instance in the sector of durable consumer goods.

-- The sector of energy supply and consumption continues to display a considerable demand for innovation and investment. Wide open fields for innovation in the energy sector are mainly the wider economic utilization of solar energy, the further development of advanced coal technologies--coal gasification and coal liquefaction--, the increased use of the principle of thermal-power coupling in long distance heating systems as well as the development of improved procedures for insulation and heat recovery.

-- In the area of environmental control the technology for the preparation and support of legal regulations and assignments will have to advance further, so that business may be able to respond with the appropriate investments and process changes. This development must start with low-emission production methods, control systems, purification processes for waste gases and waste water, the reprocessing of waste and techniques for noise abatement.

-- A great deal of innovation is required in the sector of housing modernization and urban construction. The potential of housing units requiring modernization is estimated at 6 million. Raising the standard of housing is a crucial task of social equalization.

-- Transportation tasks include the improvement of commuter service systems (such as demand-controlled systems) as well as efforts to reduce noise and pollution emissions caused by motor vehicles.

New Accents in Research Aid

The Federal Government's research policy is already establishing clear key points in all these sectors. By technological key programs, for example in the sector of energy research and energy technologies, the sectors raw material supply, marine research or environmental technologies, the Federal Government encourages especially those research and development projects in the economy, which

-- Help further develop the capacity offer of the economy in the matter of challenging technologies, such as appears necessary in the long run with regard to the world economic division of labor;

-- Aim to conserve or discover resources, especially energy and raw materials;

-- Result in technologies which reduce or avoid adverse side effects of earlier processes, for example on the environment or the workers involved;

-- Are geared to improve the accomplishment of public tasks and the infrastructure, especially in the sectors public health, the work environment, nutrition, supply and disposal, communications and transportation.

The implementation of R&D projects is always a matter for the firm itself. Government assistance is granted only if the market economic forces are not strong enough to launch the necessary research and development at all or at the right time. This applies especially to R&D projects where

-- The scientific-technological and economic risk is high,

-- The financial commitment is great,

-- The development is bound to take a long time,

--DDemand is still insufficient.

Examples are the aid to the development of breeder reactors and high temperature reactors, the encouragement of the development of efficient gas ultra centrifuges or the promotion of magnetic tracks and cabin trains. In 1976 55 percent of federal aid allocations for R&D in the sector of industry were granted to 11 major R&D development sections. This also demonstrates that the volume, complexity, financial commitment and risk of such projects require far reaching government cooperation with large firms.

Inclusion of the R&D Interests of Medium Size Firms...

Even medium and small firms now enjoy many opportunities for help from the technological key programs. The following statistics reveal some remarkable facts:

1. In the period 1972-1977 the amount of financial aid granted to medium and small firms by the BMFT [Federal Ministry for Research and Technology] quadrupled, rising from DM20 million to DM80 million. Firms with turnovers of less than DM50 million got 80 percent of the grants. In the same period of time aid to the business sector as a whole rose by only 13.7 percent.

2. In 1977 the BMFT aided 286 small and medium firms, about 40 percent of all recipients of allocations in the business sector.

3. The major part by far of the projects of small and medium firms receiving aid was related to application-oriented developments in the area of data processing, electronics and physical technologies.

The analysis of individual aid projects shows that medium and small firms may well do pioneering work. Aided were, for example, ultra sensitive measuring devices to show up traces of heavy metals in foods and waste waters; reduced-noise and safety-oriented operational devices; electronically controlled air conditioning and ventilation equipment; devices for heat recovery in industrial furnaces and dryers; modern electronically controlled tracking force systems. These examples demonstrate that the Federal Government's patronage in this sector also is increasingly oriented to economic growth geared to qualitative criteria.

Despite these commendable examples medium and small firms frequently have the tendency to accord priority to short-term development targets. It is, after all, their strong point that they have the ability rapidly to adjust products to changes in demand. At the same time their limited financial

resources compel them to seek quick success for their products. Medium and small firms are therefore often inferior to their larger confreres when it is a matter of exploiting promising innovations. Yet the short-term aims of research and development to meet current market needs are among the chief dangers to medium and small firms. They may fail early to recognize impending structural changes or underestimate their consequences. Often small and medium firms are unprepared to deal with technological revolutions.

...By Taking Into Account the Manpower Used in Research...

Even if the necessity of reorientation is recognized, firms often lack the necessary personnel for quickly coping with new and further developments. Especially at times of recession we may observe that many smaller firms reduce their development expenditure and let go personnel in development departments and laboratories. This attitude lessens the competitive chances of medium and small firms. The Federal Government therefore set up a program designed to equalize this structural weakness of small and medium firms and to improve their opportunities for employing more scientific-technical personnel in research and development. Since early this year all firms engaged in production with turnovers not exceeding DM150 million or no more than 1,000 employees may obtain allowances for the wages and salaries paid to research and development personnel up to a maximum of DM400,000 per annum. The Federal Government has made available DM300 million from the 1979 budget for just that purpose.[3] The allowance amounts to 40 percent for the first DM300,000 of documented wage and salary payments, 25 percent for expenditures in excess thereof. To have this measure take effect this year the allowances are granted on the basis of 1978 expenditures on research and development. Firms interested in such grants should apply to the Association of Industrial Research Unions (AIF) in Cologne, which handles the arrangements for the allowances on behalf of the government.

By this aid measure the Federal Government has created a new type of indirect aid intended to complement the available supply of aid.

Direct and indirect research aid complement one another; they do not represent alternatives. Direct research and development subsidies are indicated especially when research and development projects are related to the easing of potential bottleneck situations, such as in the area of raw material and energy supply. Here project-related financial aid is the most suitable approach to helping firms cope with technical-economic risks or compensate them as the case may be. While direct aid starts with definite research projects proposed by firms, which fit in with existing technological key programs, it is the aim of indirect aid by general incentives to expand the financial scope for research and development. Indirect measures such as allowances and tax concessions are therefore indicated especially when it is a matter of quickly achieving a broad impact by way of the aid granted and to benefit many recipients simultaneously.

For that reason the Federal Government has purposefully used indirect measures for the widest possible aid to medium and small firms. It also did so because in such firms quite often relatively small financial incentives are enough to balance the utilization risk of research which, there, tends to be close to the ground and oriented to quick application.

The allowances for expenditures on research and development personnel mentioned earlier are specifically designed to provide broad incentives for the modernization and improvement of production structures in the sector of medium and small firms. Improvements, though, were decided upon also in the area of the research allowance as per article 4 of the investment allowance law. These improvements emphasize aid to medium and small firms.

... And Easing of Earmarking

It was noted that the research allowance as earlier constituted was claimed primarily by large firms. As a result it tended to distort competition and encourage concentration. Consequently, in the course of working on its research and technology concept the Federal Government submitted draft legislation which was enacted and took effect on 31 October 1978. This includes the following improvements for medium and small firms:

-- A raise in the rate of allowance to 20 percent coupled with the simultaneous introduction of an annual upper limit for the investment expenditures enjoying the increase; this new provision will have the result of yielding more benefits to small and medium firms whose expenditures on research and development investments rarely exceed DM500,000 per annum.

-- The inclusion also of intangible activated assets (such as expenditure on patents, acquired know-how); this is designed effectively to aid measures for the improvement of the transfer of new technological knowledge to the area of small and medium enterprises by offering financial incentives.

-- Easing of the earmarking clause with respect to buildings, so that building modifications and extensions should benefit more than they did in the past. Up to now two thirds of a building had to be used exclusively for research and development to benefit; this is no longer to be a hard and fast rule. It is expected that this will lead to the inclusion of more small and medium firms whose research and development departments usually occupy only part of a building.

Cooperation With Research Agencies...

In addition to the measures for the promotion of research, development and innovations in the firms themselves the Federal Government is much concerned about the transfer and dissemination of scientific-technological results, experiences and skills from research to the economic and public sectors in order to improve products, processes and skilled services. Effective conditions must be established for the intensification of communications between buyers and sellers of new knowledge and technologies. It is true that

technology transfer has always largely proceeded on the basis of personal contacts between scientists and users. Yet it is necessary to emphasize technology transfer because obstacles to transfer and application tend to delay or prevent the exchange process.

For many smaller firms assembly of their own research and development capacities is often not feasible from the economic standpoint. They will have to increasingly cooperate with outside research agencies. Also if the firms own research and development departments do not have available the necessary expertise in specialized fields such as data processing and electronics, research and development contracts are perfectly fitted to help them along.

It is one of the prime concerns of the publicly supported Fraunhofer Society for the Promotion of Applied Science e.V. [registered association] (FhG) to provide contract research services to medium and small firms and advise them about the use of new technologies and the marketing chances of new products. The FhG and its 25 associated institutes boast many research capacities for application oriented contract research and development. Medium and small firms placing research and development contracts with the FhG may receive allowances from the budget of the Federal Minister for Research and Technology amounting to a rebate of up to 60 percent of the contract sum. The procedure for obtaining this allowance is free of red tape and fast.

The satisfactory experiences resulting from this type of aid have encouraged the Federal Government further to activate cooperation between medium and small firms and research intensive agencies, and to broaden the base of such cooperation. Since spring 1978 the government has begun to allocate subsidies amounting to 30 percent of the contract sum to general research and development contracts concluded by such firms. In the very first year some 100 research and development contracts received aid; the contract volume involved amounted to about DM85 million. We are certainly entitled to claim that this measure was successful when we consider the fact that smaller firms submitted particularly many applications. Some 50 percent of applications were received from firms with DM20 million turnover per annum and about 80 percent from firms with less than DM50 million annual turnover.

Furthermore the major research facilities financed by the Federal Government and the Laender to a ratio of 90:10 provide know-how to many firms. Industry profits especially from the results of applied research and development within the scope of cooperation in major projects. Even small and medium firms which do not cooperate with a major research organization may benefit from the know-how acquired there. Consequently the major research facilities have set up special offices which endeavor to encourage the use of their research and development results and aim to be available for consultation by small and medium firms.

In conjunction with the independent administrative organizations of science and business the Federal Government also initiated additional transfer measures: Special information centers and technology agencies were established

to store, appraise and transfer existing technological knowledge. Openings were developed, differing in their organizational, regional and technical structure, in order to meet the requirements of potential clients and interested parties. The personal commitment, the fund of analyses and contacts, the technical experiences and staffs are paramount in these agencies as in technology transfer generally.

... And Facilities for the Exchange of Experiences...

Jointly with the Laender and business the Federal Government provides an information and documentation program and thereby the prerequisites for better access to scientific-technological data by the expansion of 16 technical information systems. Also planned is a "patent information center." This is designed to combine in the long run the display of patent specifications and the study group patent evaluation (ARPAT) at the Fraunhofer Society, which documents publicly sponsored patents for business, and with the patent office for German research of the FhG, which aids independent inventors to take out and sell patents.

Since summer 1977 the Federal Ministry for Research and Technology has been promoting a pilot project which set up several transfer consultative offices. The project is designed to help small and medium firms especially to analyze their technological requirements and seek out the possessors of appropriate know-how. The service may be called on at the Board for Rationalization of the German Economy (RKW) Land group offices in Frankfurt, Hannover, Saarbruecken and Stuttgart, and at the chambers of industry and trade in Koblenz, Moenchengladbach, Siegen and Heidelberg. Also within the scope of the pilot program advice may be obtained from the Berlin VDI technology center in matterns concerning the application of microprocessors, the Berlin technology agency and the East Bavarian Technology Transfer Institute in Regensburg. The offers of information by the innovation consultative offices found an immediate response pointing up the readiness of small and medium firms to tackle their own research and development provided they are assured of assistance and need not carry all the risks involved. The Stuttgart RKW, for example, advised 179 firms in the period from July 1977 to May 1978. Dealt with here were primarily questions about new products and processes, information on available grants, patent questions and help with licencing negotiations, the search for types of cooperation and institutes handling contract research. The pilot projects are intended first of all to persuade the leading business organizations of the need for innovation-oriented advice and encourage them to take their own initiatives. In the meantime we may claim success for the government initiative by virtue of the fact that some chambers of industry and commerce have on their own accord established self-financing advisory offices.

... For Project Realization

The transformation of research and development results into marketable products often calls for substantial investments in fixed and current assets,

which tend to place a considerable financial burden on small and medium firms in particular. Designed to help the construction of appropriate production facilities in these cases are especially the Wagnisfinanzierungs-Gesellschaft (WFG) [Venture Financing Company] which provides direct investment capital and, in some sectors, the ERP [European Recovery Program] which makes available low-interest loans. The first experiences of the WFG show that aid for technological innovations at small and medium firms involves particular difficulties and specific features. Such aid applies to new products and procedures; marketing prospects here tend to be extremely uncertain and marketing risks extremely great. Many products fail at the hurdle of the necessary patent protection. Norms and testing regulations may not be compatible or disadvantage the new product, thereby making its introduction on the market even more difficult. Often the necessary basic capital resources are lacking. Since its establishment in July 1975 the WFG has committed itself to 20 investments in small firms or new firms for the purpose of marketing a technological innovation. It has made available a total of DM17 million in capital funds. Currently WFG management planning is providing for a dozen new investments per annum. The build-up services of this "venture financing" enterprise will be fully appreciated by those who are aware of the results of old established private capital inveatment companies which, after a long preliminary stage, may have achieved possibly 10-15 investments in other companies.

Progress No Longer an End in Itself

Admittedly the problems now confronting the economy and the government with regard to technological innovations are not confined to finances. An increasingly critical attitude to technical development may be observed among the public, especially the young. Many people now expect technical development to destroy the natural environment, to threaten public health and jobs. Just because we know that science and technology continue to be the guarantors of prosperity in our country we are bound to seriously consider the potential dangers of scientific-technological development to peoples jobs and recreation. The Federal Minister for Research and Technology therefore believes it imperative to strengthen the process on discussion on technical change and the problems related thereto, and to provide a broader basis for this dialog by involving the major social groups. A beginning will be the technological dialog which is designed in particular critically to discuss the key points and criteria of technological policy as well as the possible consequences of the promotion of technology. Such a dialog offers an opportunity for the sober discussion of technical developments with the social groups concerned.

Within the framework of such a dialog we will also have to rephrase the question about the meaning and the goals of the joint efforts of government and business. This is all the more necessary because the public is increasingly discussing the relation of economic growth to working hours.

We must learn to appreciate that our industrial production method is based on the rational use of resources and consequently realizes "lasting advances"; this also and primarily implies rising productivity. It would be most inappropriate for us to obstruct such process innovations, and the attempt would do us the utmost harm. In that case new technologies would simply be purchased abroad. There is no alternative to the use of technology. Industries and firms which fall behind in the development of new product and process concepts lose their international competitive edge. In such cases it is more sensible to seek entirely new fields of operation, future innovation potentials, to ensure growth and employment.

After a phase favoring the demand and supply of mainly material goods, demand now appears increasingly to shift to intangibles such as advanced education, more leisure and self-realization accomplished by service to others. Undisclosed reserves are most likely to be found in the services sector. According to the United Nations Statistical Year Book, in the mid-1970's the Federal Republic and Japan, at 27 percent and 24 percent respectively, had the smallest percentage of services in the social product but the largest percentage of industry at 45 percent and 37 percent respectively. There is a considerable need to catch up in the sector "social services." It should also be possible to obtain a consensus and the appreciation that working hours should gradually be reduced and rises in productivity cautiously translated into more leisure. It will be a delicate matter to determine the extent of these changes so that, on the one hand, we do not injure the competitive capacity of our economy and on the other keep unemployment within manageable limits.

Nobody has a ready prescription for all the problems discussed; even the governmental aid measures sketched can only serve as orientation and assistance to the firms own innovative policy. Yet the latter must receive greater emphasis if we wish to maintain our opportunities in an increasingly complex world. "Innovare necesse est" [innovation is a necessity]: This maxim represents a permanent task for our economy; the government cannot afford to slacken its efforts to drive home this challenge.

FOOTNOTES

1. See G. Friedrichs, "Use of Microprocessors," RATIONALISIERUNG No 29/1978, pp 157 ff and 9 ff, pp 207 ff; also Mengels/Rebel, "Microprocessor and Machine Construction," RATIONALISIERUNG No 4/1979, pp 87 ff, No 7/8/1979, pp 185 ff, No 10/1978, pp 258 ff.

2. See pp 722 ff of this issue.

3. See RATIONALISIERUNG No 10/1979, column "Daily Reports from the Federal Ministry for Science and Technology," pp 262.

FEDERAL REPUBLIC OF GERMANY

PROSPECTS FOR MICROELECTRONICS IN MACHINE TOOL INDUSTRY

Munich RATIONALISIERUNG in German No 10, Oct 79 pp 258-261

[Article by Dipl Eng Walter Menges: "Microprocessor and Machine Tool Construction"]

[Text] In the first article under this title (No 4/79), the role of microprocessors (µp) as significant functional or control elements of microcomputers (µc) was presented. In the second article (No 7-8/79), examples were used to show the areas of machine-tool construction where a penetration by microelectronics (µE) is to be expected. In the present (third and last) article on the topic, an attempt is made to quantitatively estimate the impact of microelectronics on the technical area of machine-tool construction.

In the previous article of this series*, generalized system components which are used in all machine-tool products were defined:

Class 1. Force reacting, generating and transmission systems, such as frames, motors, axles, crank shafts, couplings, etc.

Class 2. Mechanical, hydraulic, pneumatic, electrical (separate and combined) sense, sequence and control systems, such as cams, templates, relays, etc.

Class 3. Electronic (information storage and processing systems), such as hard-wired logic components of an elevator controller, a printing-press process computer and machine-tool controller.

To illustrate these once more, the components of a typical machine tool are presented in Figure 1.

* Rationalisierung No 7-8, pp 185 ff

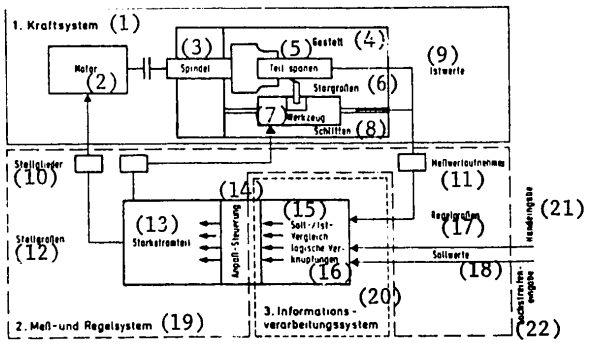

Figure 1 Machine-tool system components

Key:

1. power system
2. motor
3. spindel
4. frame
5. work place
6. perturbations
7. tool
8. carriage
9. present value
10. actuator
11. transducer
12. servo output variable
13. high-current section
14. interface control
15. target value/present value comparison
16. logic switches
17. control input variables
18. target (reference) value
19. sense and control system
20. information processing system
21. manual input
22. punched-tape input

Here it is immediately obvious that the power system components can never be replaced by microelectronics. Their function is to transmit or absorb forces.

The situation is different with the second and third classes of system components. The third class of components, of course, represents information processing, thus, the actual electronics which operates at low current levels and, in the language of controls engineering, has the task of processing input variables into command variables. The sense, sequence and control system is the high-current section. Here the command and control variables are transformed into output variables. This transformation is called interface control, that is adapting the low-current information data to the high-current data or impulses which make it possible for the output transducers such as positioning motors, hydraulic valves, etc, to carry out their functions. If one assumes that in the future the actual control, or information processing section, can be replaced by microelectronics to the extent of about 80 percent, then the interface control, that is the transformation section ahead of the sequence and control section, can be replaced only to the extent of about 20 percent.

If one simplifies the consideration and combines the microelectronics potential of both sections, the result is that, on the average, about 50 percent of the system can be replaced. The following consideration can be added.

If the fractional value for the system components of classes 2 and 3, thus the information processing components and the bulk of the sense, sequence and control system components, for representative products of the machine-tool industry is available, then a model calculation is possible, using the above derived estimate, which can predict the value of machine-tool parts which can be replaced by microelectronics in the future.

Fractional Value of the Sensing and Information Systems by Product Group

Estimates made of the fractional value of the system components approximating those of classes 2 and 3, based on the value of various products of the machine building industry, resulted in the values listed in Table 1.

The listed percentage values of the estimates vary considerably in the individual case. In elevator installations, for instance, the system components related to information processing, sensing, sequencing and control can have a fractional value of up to 40 percent in exceptional cases.

If one breaks down the products used in the estimate into subsystems and ratios the subsystem costs on product costs, then the percentages for the subsystem component classes are:

Class 1.	Power system	91%
Class 2.	Sensing, sequencing and control system	6%
Class 3.	Information processing (electronics)	3%

Manpower Consequences in Machine Construction

With the accounting parameters "total manpower expenditure" and "manpower expenditure per product," it is easy to make a rough calculation of the number of people involved in the manufacturing of the individual system components.

Table 1. Fractional value of sensing, control and information processing systems in products of the machine building industry

Up to 5% -
- Moving steel structures, such as rotating restaurants, traveling platforms, steel hydraulic structures (dams, etc), large antennae (radio telescope)
- Railway vehicles (cars)
- Mine and shaft conveyors
- Dock and shipbuilding equipment
- Smelting equipment
- Compressors

6 to 15% - Printing presses
- Diesel engines
- Cranes
- Transporting and conveying equipment (mining engineering)
- Oil and gas combustion systems
- Turbo compressors
- Electric trains

16 to 30% - Elevators
- Automated warehouse equipment (pallet stackers)
- NC machine tools

over 30% - Automatic instrumentation and test systems (x-ray and ultrasonic systems) for steel structures, etc.

Considering product structure and converting to labor units, the fractional value of components in "sensing, sequencing and control systems" corresponds to about 5 percent manpower equivalent; and the fractional value of the subsystem components in "information processing systems," which contain predominantly microelectronics, corresponds to about 3 percent labor equivalent. Components of these systems, of course, were formerly, and will also be in the future, purchased by special companies in the electronics industry--up to 80 percent, estimated on the total fractional value. Including the 50 percent replacement derived above, a computed 0.8 percent of the jobs in the machine building industry will be affected.

This means that through the introduction of microelectronics in machine products not even 1 percent of the jobs, overall, is endangered.

Now, it has often been made to appear that such a displacement would happen all at once. This absolutely does not reflect reality. Rather, such a fundamental conversion from mechanical/electrical system components to microelectronics requires a certain amount of time. In addition, many interface system elements still require development; and also the necessary process of retraining workers must precede as a prerequisite to broad realization. In the machine building industry, a time span of at least 5 years must be considered. At this point it should be pointed out once more that with the advance of microelectronics technology, a progressive replacement of "hardware" by "software" takes place, and the development of "software" is extremely labor and time intensive.

If we introduce these 5 years into our model calculation and relate this to the 0.8 percent total affected jobs just computed, the result is that by the injection of microelectronics into machine products, a yearly total of 0.16 percent of jobs will be affected.

A second aspect for study is the more economical manufacturing of products or product components by use of microelectronic controlled processes, for example, microprocessor controlled machine tools (CNC). The question here is how many jobs will be lost due to the higher productivity of this new generation of machines. Let us make a model calculation here also.

If one starts with the lathe, the most widely proliferated machine tool of the machine building industry, and considers the percentage of presently used lathes which can reasonably be replaced by CNC machines and further considers the average shift loading of these lathes, then studies show that, overall, about 12.5 percent of current lathe jobs will be lost by introducing CNC machines. However, partly offsetting this is about 4.3 percent of new jobs which will be required in the application of the CNC machines (machine operators, riggers, programmers).

If the economizing potential for the lathe is carried over into a broader model including milling, boring and similar machines; if it is assumed that an equally high substitution effect is possible for these machines and a calculation is made for the entire German machine-building industry with an inventory of about 68,000 machines, then the result is that in the machine building industry of the FRG, about 8 percent of the industrial jobs will be affected during the conversion period by using this new technology. At first glance, this appears to be high; however one must not forget that these machines will be installed in the manufacturing plants over a period of several years. Further, if the established conversion period of about 7 years for a large German tool building firm is taken as the industry average, then that means for the industry or its industrial workers that, because of adopting these highly productive machines, annually about 1.1 percent of them will have to look for other work, or that these jobs will no longer be filled--which presents no problem in view of the fact that there is clearly a shortage of skilled workers.

--If one combines the results of these two model calculations, that is the substitution effect and the economizing effect, then it is realistic to expect that barely 1.3 percent of the jobs in the technical area of the machine building industry will be affected annually due to using micro-electronics--however, one must keep sight of the limited accuracy of such a model calculation.

If one should, however, consider this level to be worrisome, then it should be considered in the light of the following:

--An acute shortage of skilled manpower prevails in the German metalworking industry and will persist for the foreseeable future. For the business firms selected for this study, it can be shown that, to date, not a single skilled worker has been put out of work because of the new machines. Instead, a most pressing shortage of skilled workers has been somewhat mitigated by this development.

Decisive for Competitiveness

The reason why there is no longer any need to fear that qualified workers will be put out of work by using this new technology but, to the contrary, the market strength, and thus the growth of the German machine building industry, can be improved is supported by the following example:

In a main product area of a machine building company, careful studies have been carried out over a period of several years to determine what factors have led to the loss of contracts, especially against international competitors. In recent time the factor of price has more and more turned out to be the cause for loss of contract. Consequently, studies were conducted to determine the increase in contract volume as a function of decrease in price. The result:

--In total, about 37 percent of available contracts were lost due solely to price disadvantages.

--With a price about 15 percent lower than actually bid, contracts for about 13 percent more of the market could have been won. This lower price was not acceptable, however, because it was significantly below the production cost.

Using the known structures of labor expenditure, labor costs, number employed and fraction of these products in the total market, one can roughly calculate that the volume of contracts which could have been won at a bid 15 percent lower than the competition would have produced 20 percent more jobs.

Thus the assertion can be ventured that, through the improvement of the functional quality and the price/utility ratio of machine products by conscious redesign for the widest possible use of microelectronic system components on the one hand and consistent use of microelectronic controlled production machines on the other, the German machine building industry, in spite of its higher labor cost level, can regain a position from which it can stop, and even reverse, the trend toward squeezing German products out of international markets.

Without including new products or additional possibilities through the use of microelectronics, the results of this model calculation--of course, subject to some ifs and buts--can be presented as follows:

--Using microelectronics components in products on the one hand and for manufacturing economies on the other, will affect about 1.3 percent of jobs annually. At the same time, however, by an improved competitive capability driven by consistent application of microelectronics, the number of new jobs which can be created each year will be a multiple of this figure.

In order to realize an increase in contracts and to secure an increased share of the market compared to the international competition, it is necessary to integrate microelectronics into machine building products as fast as possible. Only in this way can a lead over the international competition be achieved.

The United States and Japan are already far out front in this field. Fast reaction is thus necessary to realize the "pioneering profits," that is to extract substantial profits before the new technology has proliferated and is taken over by low-wage countries which can offer the products at a much

lower price than we can. We need these profits to protect our technology edge, to finance additional investments, especially education programs and development--in the end, to retain jobs in our country, yes, and to create new jobs.

Qualitative Effects on Jobs

Finally, the qualitative effects of microelectronics on the manufacturing organization and its workers will be sketched briefly in the following.

The application of electronics in computer technology has made possible the amplification of human intelligence--until now, primarily through centralized electronic data processing installations. The miniaturization of electronics now makes possible decentralized intelligence amplification with its increased flexibility*. More and more, man will have to learn to interact with computers, as he has already learned to interact with today's small, hand-held electronic calculator, especially in view of the fact that programing languages is becoming ever simpler, thus simplifying handling of the systems.

Ever greater latitude for operator interaction is made possible by virtue of the decentralized intelligence of manufacturing machines equipped with microprocessor control systems. Therewith, the individual capabilities of man are better used than before. The computer will become for him an indispensable tool. Since man--here, the skilled worker--will once again be put in a position to transmit his own knowledge and skill to the machine via the intelligence-amplifying CNC control, the job will become more interesting and the monotony will decrease.

The heretofore strong division of labor between programing and work queuing on the one hand and job execution and machine control on the other can be brought together again in certain areas, such as single item or low-volume production, right at the machine by using an integrated work process. The result will be smaller organizational units in manufacturing with previously unknown flexibility. The master craftsman and foreman will finally be relieved of the dubious task of factory schedule chasing and be forced back into their neglected leadership functions.

This restructuring will only be successful, however, if the training of our young and the further training of our experienced and older skilled workers is attacked as soon as possible in every important aspect. It is important to adapt the training and capabilities of the skilled workers to the new requirements and to prepare them for their responsibilities. At the same time, the conventional manager must learn to practice a style of management

* See Warnecke, H.J. et al: "Mikroelektronik ist unverzichtbar" ["Microelectronics Is Unavoidable"] in "Blick durch die Wirtschaft" ["A Survey of the Economy"] 23 July, 1979

in keeping with the times. A new type of interdisciplinary team worker with high technical knowledge and dedication to the task is required to bring about the restructuring of industrial practice. Naturally, the man/machine system also requires finer tuning on both sides, and for this a basic analysis of all relevant parameters as a function of quality and importance is necessary.

This process must receive support to the end that control systems and computer processes are tailored to the needs of the users and operators.

Computer jargon and the mystic rites of EDV must be relegated to the past; interaction with computerized control and with the computer must become commonplace.

It is even foreseeable that the monetary value of microelectronics, both in products of the machine building industry and in manufacturing, will become a relatively small percentage. However, microelectronics will assume a key role in product function and in the economic manufacturing of product components. Also, in harnessing organizational processes such as manufacturing control, microelectronics will make possible the attainment of completely new horizons, a greater measure of economics and greater latitude for decisions by workers.

Conclusions

In summary, it can be said:

1. Microelectronics will assume in the future--although not in order of importance with respect to value--a key position in machine construction mainly in relation to product improvement, to a lesser extent with respect to product innovation.

2. Replacement of mechanics by electronics will naturally only take place with some time lag since the required change in thought and learning process is just beginning; and, besides, the reliability of many composite mechanical-electronic subsystem must be improved. This does not mean, however, that society can sit and wait for these developments, rather everything possible must be done to accelerate this thought and learning process.

3. In specific areas such as the expansion of functions in conventional products, for example, automatic data acquisition and evaluation systems or operator displays, etc, the application of microelectronics will take place relatively fast.

4. In the service and control field, from installations or processors to complete manufacturing and production processes, completely new job areas will be opened up through the use of microelectronics.

5. Design, development and manufacturing will be meshed much more closely than before due to the capabilities of microelectronics.

6. Microelectronics will make it possible, through its role as a decentralized intelligence amplifier, to create a new flexibility in many operations which also means work enrichment and increased productivity.

7. The capability and willingness of, and opportunity for, our workforce to train for jobs in the field of microelectronics in all areas affected by microelectronics will in the future take on a much more important meaning than in the past as concerns the development of our economy. Here everything possible must be done as quickly as possible to lay a broad base for these activities.

8. To create a panic with respect to the effect on existing jobs caused by applying microelectronics and microprocessors in machine construction is to misinterpret the facts--if for no other reason, the structure of the product itself. To the contrary, the systematic, rapid and consistent integration of microelectronics with all its possibilities is indispensible. This means, in particular, "social acceptance" toward removing existing distrust and advancing this helpful technology.

It is necessary that the potentials and effects of microelectronics be analyzed factually and constructively. The "Dialog on Technology Policy" just introduced by the Minister for Research and Technology is an appropriate vehicle for this--but it must not be a matter of endless discussion.

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CSO: 3102

NORWAY

SECONDARY OIL RECOVERY METHODS IN USE IN NORTH SEA FIELDS

Oslo NORSK OLJEREVY in Norwegian Nos 9-10, 1979 pp 15, 16

[Excerpts] The secondary recovery methods which are treated in this article are all used in the United States, but the results are extremely varying. Experiences from the United States where the reservoirs are well defined with an extensive production and injection history indicate that it is too optimistic to trust in an immediate success for secondary recovery in the North Sea. But if today's or the future's secondary recovery methods gain widespread use in the North Sea and in addition are technically successful, this will have a significant effect on oil production from the well-known Norwegian reservoirs in the years 1985-2000. Secondary recovery is planned in more reservoirs in the North Sea, and the steadily increasing experience from the Ekofisk area is putting both companies and authorities in a better position to assess attempts to increase the degree of recovery. It is a fact that the best effect from secondary recovery is gained early in the production phase. Therefore many of the companies which are operators in the productive fields in the North Sea have evaluated secondary recovery before the development plan has been worked out. Because secondary methods have equipment requirements, platforms and building projects, besides, must be dimensioned accordingly. If development plans do not include secondary recovery, it is both difficult and expensive to modify and expand the equipment for secondary recovery.

The planning of secondary methods is based on estimates of the reservoir's volume of oil and estimated degree of recovery, and these parameters are often uncertain early in the production phase. As long as uncertainty prevails regarding the reservoirs' size, porosity, permeability, fluid saturation and residual oil saturation, a technical and economic analysis of methods to increase recovery will be unreliable. Although we know the reservoir's size and behavior sufficiently well, the use of an advanced displacement method will remain a very demanding project.

As an example we can look closer at the water injection project which started in the Forties Field in December 1976. This reservoir has a void content on the order of magnitude of $1.3 \cdot 10^9$ m^3. In order to achieve satisfactory displacement effectiveness, it is necessary to inject a displacement cushion with a minimum volume of 5 percent of the void content. For this reservoir we must accordingly have a chemical fluid in the front with a volume of $65 \cdot 10^6$ m^3. With a chemical concentration of 5 percent in the front fluid, there will be a need for $3 \cdot 10^9$ kg of chemicals, and it will take 3 years to inject them. In other words 3,000 tons of chemical per day are required. This is more than the capacity of the largest plants which produce surface-active chemicals. In order for chemical displacement to be a truly applicable method in the North Sea, research efforts must be increased in chemistry and reservoir technology for the purpose of developing more effective injection fluids.

Several of the Norwegian fields in the North Sea have been planned with secondary recovery by gas or water injection. The following gives a brief summary of the plans which are under consideration for individual reservoirs.

Ekofisk: The gas produced for which there is no sales capacity is injected into the reservoir, and according to the Oil Directorate this is favorable for the degree of recovery. Since the injection started, 10 billion m^3 (NTP) of gas has been injected. This, according to the Oil Directorate's calculations, has resulted in an increase in oil recovery of about 10 million tons. Laboratory studies of gas displacement under reservoir conditions have been conducted and indicate that the natural miscibility of gas and oil results in effective displacement of the oil.

Ekofisk is a limestone reservoir with a microscopic fissure system and water injection in this type of formation is met with skepticism because one expects the breaking through of water early in the process. At the same time calculations have shown that the degree of recovery can be increased by pumping water into the reservoir. But several problems arise in this connection: 1) The result is best if water injection starts while the pressure is high. Now the pressure in Ekofisk today is already far below the bubbling point, so that time is quickly running out for this project. 2) Production at Ekofisk has been planned with the relieving of pressure, which means that several platforms are necessary if one wants to inject water. 3) Investigations thus far do not provide enough of a basis for estimating how effectively it is possible to displace oil by injecting water into the reservoir.

V-Ekofisk and Albuskjell are condensate fields where the degree of recovery is high with the relieving of pressure. The degree of recovery can be increased further by injecting amounts of gas of the magnitude of the amounts of condensate produced.

The Tor and Eldfisk reservoirs should both be potential candidates for both gas and water injection, since the degree of recovery with the relieving of pressure is expected to be low. A model study of water injection in Eldfisk indicates that the recoverable amount of oil can be doubled.

When it is a question of secondary recovery by pressure maintenance and gas displacement, one ought to estimate the degree of recovery for the whole Ekofisk area. The wells should be closed in the oil fields which produce a large amount of gas, and rather cover the need for gas (for sale and injection) by production from the condensate fields. This will increase the degree of recovery for the Ekofisk area as a whole.

Frigg is a gas-bearing sandstone reservoir with a high degree of recovery. An uncertainty factor is how strong the inflow of water from underlying formations will be. Reservoir studies indicate that the degree of recovery will be 90 percent if the water penetration is limited, while it will be 60 percent if there is a strong inflow of water. The reason for this is that the production of water will be so great that the wells must be closed.

Statfjord has been planned with secondary recovery from the start, with water injection in the Brent Reservoir and gas injection in the underlying Statfjord Reservoir. The water will be injected in the bottom of the Brent Reservoir and the oil will be produced from a higher level. Mobil assumes that 70 percent of the oil present will be displaced by the water front. Measurements in the laboratory have given a displacement effect of 50 to 80 percent. The areal coverage and the contact factor have been estimated at 0.85 so that the total degree of recovery will be (0.85)70 percent = 60 percent. Reservoirs are very often more complex than the models which are used in calculations, so that the plans for the Statfjord Field have been based on a degree of recovery like 50 percent. In the Statfjord formation gas will be injected at the top of the reservoir. The gas is naturally miscible with oil and will displace all the oil it comes in contact with. It is however difficult to estimate the areal coverage and contact factor for this type of displacement. The well placement and production rate will be significant for the areal coverage in gas displacement. If the Statfjord Field were to be produced without secondary recovery, the degree of recovery would be on the order of magnitude of 25 to 30 percent. It is clear that the Statfjord Field is an excellent candidate for chemical displacement, since the residual oil saturation after water displacement is as high as 25 to 30 percent. If it is possible by chemical additions to remove this residual oil saturation entirely, the reserves will increase by about 100 million tons of oil and 25 billion m^3 (NTP) of gas.

Concluding Viewpoints

It is obvious that the use of secondary recovery methods is a field which must be assessed very seriously in connection with the recovery of petroleum on the Norwegian Shelf. These methods have a potential economic significance which is important. The fact that these methods have not been completely developed and are also not entirely understood must not be a decisive argument for Norway's having no part in this field of work. Much of the research which has been done has various regional limitations. By far the major part has its starting point in the reservoir in the United States. Only to a limited degree can the conclusions be carried over to conditions of the North Sea. The Norwegian contribution which is being made today to studies of secondary recovery methods is being made at SINTEF [Society for Industrial and Technical Research] in Trondheim. In part this has its basis in studies of the fundamental mechanisms, and is based in part on displacement experiments with water and added chemicals. At year's end begin experiments with miscibility displacement in cooperation with the Institute for Continental Shelf Investigations. These studies are forming the foundation for Norway's contribution to important international research cooperation taking place under the direction of IEA (International Energy Agency in Paris).

It must be a minimum objective that Norway have at its disposition professional competence in secondary recovery methods. It must be effective enough to be able to accompany the extensive research which is being done internationally in this sector, and to develop it for use on the Norwegian Shelf in cooperation with the oil companies. This presupposes term investments for both laboratory equipment and personnel, to an extent which permits the building of competence and recruitment as needed. In today's situation Norwegian research environments have not been provided opportunities for even approximately fulfilling such an objective.

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